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PRONE AND POSTURAL RESPIRATION

IN

D R O W N I N G

ETC.

Unica spes est, unicum remedium.



—— *sævamque exhalat*——*Mephitin.*

VIRG. *ÆN.* lib. vii, l. 84.

DR DOUTY

PRONE AND POSTURAL RESPIRATION

IN

DROWNING

AND

OTHER FORMS OF APNŒA OR SUSPENDED RESPIRATION ;

BY

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ETC. ETC.

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1857

THIS LITTLE VOLUME IS DEDICATED

TO

GEORGE WEBSTER, Esq. M.D.

OF DULWICH,

IN TESTIMONY OF AN UNINTERRUPTED FRIENDSHIP

OF THIRTY YEARS;

AND TO
THOSE STUDENTS OF ST. GEORGE'S HOSPITAL*
WHO,
WITH SUCH ZEAL, ABILITY AND PERSEVERANCE, WORKED OUT
THE PROBLEM OF
POSTURAL RESPIRATION ;

By MARSHALL HALL, M.D. etc.

AUGUST, 1857.

* EDWARD LONG FOX, ESQ. (NOW M.D. OXON).
CHARLES HUNTER, ESQ. AND ROBERT L. BOWLES, ESQ.

I HAVE made it a sacred duty to assist in editing this my Father's latest work, during the protracted and severe illness, which terminated on the eleventh of this month in his death—in a loss irreparable to the whole scientific world.

This final leap of an expiring flame is far from being the least brilliant of my Father's gifts to his profession and to humanity.

My task has been easy. I have had little to do, except to gather together and arrange the papers which have appeared in a pamphlet and in "The Lancet," and some M.SS.

I should willingly have adopted the title given to the life-restoring process of pronation and rotation of the patient dying of apnœa, by the Editor of that journal, and so cordially adopted by the profession :

"Any thing more simple, philosophical, or beautiful, could not have been devised. It is proposed to call the plan the READY METHOD of treating the drowned. Infinitely preferable, in our opinion, would be the title of THE MARSHALL HALL METHOD. This designation is due to the distinguished discoverer; and the method would thus be benevolently associated with his name to the end of time."

MARSHALL HALL.

Blacklands, Calne, Wiltshire.

August, 1857.

PREFACE.

I am unwilling entirely to discard the evidence given by so many who have treated apnœa, of *recovery* after a very long immersion. And I have endeavoured to imagine an event possible which has been rejected because it has appeared impossible.

What takes place when all respiration and all circulation have apparently ceased? For from such a state, in new-born infants especially, the patient *has* recovered.

Is there a low state of *chemical* change still persistent under the influence of apnœa and cold, from which even the adult may be restored under the genial influence of a gentle stream of atmospheric air into the pulmonary air-cells and on the general surface of the body?

The damp hay-stack smoulders until some occasion occurs of its low combustion being roused into spark and flame.

And a *capillary* circulation and its blood-changes *may* continue, when the heart has already ceased to contract, which may render such restoration to life not impossible. A frog in which, from the exclusion of oxygen, the cutaneous circulation has ceased, if observed under the microscope, has been known to become *spontaneously* restored on exposure to the atmospheric air.

Much more might be said on this subject and on low and spontaneous combustion. Meantime, let us persevere with our prone and postural respiration with alternate pressure, and wait and watch and hope; an efficient artificial respiration has *never* yet been so promptly or rather instantly applied as it may now be by means of—Pronation and Rotation.

An investigation is opened to us full of promise of life, even in cases of extremely *long duration* and unavailing *protracted treatment*. We must cease to be sceptical. Still-born infants have been restored after a considerable lapse of time.

PART THE FIRST

IS NEARLY A VERBATIM REPRINT OF THE ESSAY PRESENTED
TO THE ROYAL HUMANE SOCIETY IN JANUARY 1856.

PART THE SECOND

CONSISTS IN A SIMILAR REPRINT OF PAPERS PUBLISHED IN THE
LANCET SINCE THAT DATE, WITH OBSERVATIONS
NOT YET PUBLISHED.

CASES.

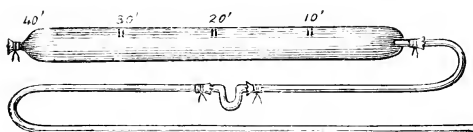
WITH NOTES ON OBSOLETE MODES OF PRACTICE.

PART THE THIRD

CONSISTS IN SEVERAL PHYSIOLOGICAL VIEWS BEARING UPON
RESPIRATION AND APNŒA.

PART FIRST.

THE PNEOMETER^{*}



OR MEASURER OF POSTURAL RESPIRATION.

* Vide p. 61.

PART FIRST.

POSTURAL RESPIRATION

IN

DROWNING,

ETC.

§ 1.—*Introduction.*

IN the following pages I propose to treat of Apnœa (from α , priv. and $\piνew$, respiro), its rationale and treatment, in so succinct and plain a manner as to be useful to those most interested in the *practical* results of such inquiries. I shall keep in view that it is to promote the benevolent objects of the Royal Humane Society that my efforts are made.

My first aim will be to give a clear view of the *nature* of the effects of suspended respiration; my second, to state the best means of restoring the patient affected by that suspension.

The nature of normal respiration is entirely different from that of the apparently respiratory movements in continued apnœa. The former is, as will be more distinctly explained hereafter, *reflex*; that is, it is *excited* by the carbonic acid exhaled from the blood into

the air-cells of the lungs, through nerves which proceed to the spinal *centre*, traverse it in some mysterious manner, and proceed from that centre to the muscles of respiration; the latter are *centric*, and are caused by the action of the carbonic acid retained in the blood, acting on the spinal centre itself and through certain nerves which proceed from it on the muscles moved, which are also different from the former ones.

This distinction, which is of the utmost importance, has been established by my own experiments.

During the circulation, the oxygen inhaled in respiration unites with the carbon in the blood, forming carbonic acid. This carbonic acid is exhaled in respiration in its turn, except in the cases in which the respiration is suspended, as in drowning and other forms of apnœa.

In apnœa, the carbonic acid retained in the blood first poisons the brain, producing anæsthesia, unconsciousness, and immobility; and then the spinal centre, producing the gaspings so characteristic of this condition, and constituting the last *external* sign of life.

After this, there is still a slight lingering movement of the heart, on which the feeble hopes of the restoration of the patient repose; but speedily true asphyxia (from α , priv. and $\sigma\phi\nu\zeta\omega$, pulso), or the cessation of all pulsation and circulation, occurs.

Such is the course of events when the suspension of respiration is complete. It is usually rapid and of short duration. Sometimes, however, the suspension of respiration is not absolute; the patient may rise to the surface

and breathe; or there may be a state of *syncope*, or of *shock*, produced by the circumstances of the accident and inducing a *feeble circulation*; and then the duration of the apnœa, with the hope of restoration, is more protracted, that hope being directly as the persistence of the respiration, and inversely as the rapidity of the circulation.

The further hope of respiration by the means we employ is again directly as we *excite* or *imitate* respiration, the restoration of the circulation being promoted by shampooing, the warm bath, &c. only as subsidiary and *secondary* to respiration.

We must never forget that the circulation is a *self-poisoning*, the respiration a *de-poisoning*, process. These are the two principles by which we must be guided in our treatment of apnœa. On these topics I proceed to treat more at length in the subsequent sections. I beg my reader to pardon a few repetitions.

§ II.—*The Distinction between Respiration and the Respiratory Movements in Asphyxia.*

Every one is familiar with the effect of dashing cold water on the face, or of descending slowly into the cold bath. The cutaneous nerves of the face or general surface are impressed with the cold, and *excite*, through a reflex action performed through these nerves and the spinal centre, acts of inspiration.

Every one has experienced the effect on the nostrils of the carbonic acid evolved from the stomach after taking draughts of soda water.

In ordinary circumstances, it is the carbonic acid *gas* exhaled from the blood through the fine membranous tissues of the pulmonary air-cells, which, by exciting the fine fibrillæ of the pneumogastric nerve spread over those air-cells, proves the constant *excitant*, through those nerves and the spinal centre, of the normal acts of respiration.

To be more explicit, I may add that, in respiration, oxygen gas is inspired; it is absorbed into the blood, and circulated with it; in its systemic course it unites with carbon, and forms carbonic acid; this circulates in the venous blood in its turn, is exhaled from it, proves the excitant of a fresh inspiration in the pulmonary air-cells, and is finally expired into the atmospheric air.

These acts I have designated reflex or *diastaltic*, because they are performed along certain *in-going* nerves, *through* the spinal centre, and along certain *out-going* nerves eventually distributed to the muscles of respiration. This *diastaltic* action is the essential character of the *physiological* acts of respiration.

All is changed in the case in which the normal acts of respiration are obstructed, as in apnœa.

When the respiration is entirely suspended, there is no exhalation of carbonic acid, the excitant of respiration; there can therefore be no *diastaltic* respiration; but the carbonic acid which ought to be exhaled in the lungs is

retained in the blood, poisons it, circulates with it through the system and its various organs, and excites various abnormal conditions and actions. The mode of action is now not *diastaltic*, but centric in the spinal centre and *ecstaltic*. The respiratory movements are no longer normal and rhythmic acts of inspiration and expiration, but abnormal and irregular *expiratory* movements, with a peculiar opening of the mouth, flexion of the body, and frequently with the ejection of foam, followed by *inspiratory* efforts. Such is the character of the respiratory movements in apnœa. They are *pathological*, not physiological; and they are, I repeat, centric or *ecstaltic* from the spinal centre, not *diastaltic*, *through* it.

The blood is poisoned by the carbonic acid so retained; the organs are poisoned in their turn by this blood-poison. Our most strenuous efforts must be exerted to eliminate and remove this poison from the blood and from the system. All other efforts are subsidiary, although auxiliary; and, if they at all take the place of this, injurious.

The *only* mode of thus eliminating the carbonic-acid blood-poison is, to *excite*, or *imitate*, *Respiration*—the one idea which it is the object of these pages to enforce.

Adopting fully the beautiful device of the Royal Humane Society, I would carry out its meaning still further, and say that so to *blow* the latent spark into flame, is our hope, our only hope;—*unica spes est, unicum remedium*.

To revert to the specific topic of this section, I would again say—and this knowledge is entirely the result of my own labours—that whilst the normal respiratory movements are *reflex* in their mode of excitement, the movements in apnœa are *centric*. Of the former character too is the *panting*, which may be designated *hyperpnœa*, observed in some experiments to be detailed hereafter; and of the latter, the peculiar phenomenon of *gasping*, which may be termed, from its equivocal character, *pseudopnœa*.

§ III.—*Relation of Respiration to the Circulation.*

There is the strictest relation between the rapidity of the circulation and that of the respiration. The number of the pulsations of the heart preserves, in all physiological conditions, the same *ratio* to the number of respiratory movements. If the circulation be augmented, the respiration becomes more frequent; if the circulation be retarded, the respiration is proportionately slower.

This ratio between the number and force of the contractions of the heart and the number of the acts of respiration is physiological, the result of cause and effect and essential to life and health, in its varied forms and conditions.

As the blood circulates, it receives the vivifying effect of oxygen, and forms carbonic acid. This carbonic acid

is exhaled through the fine membranous tissue of the air-cells, and coming then in contact with the minute *origins* of the pneumogastric nerve, the internal excitor respiratory nerve, excites the successive acts of respiration.

The formation and the evolution of this carbonic acid is greater in proportion to the quickness of the circulation; the rapidity of the respiration is proportionate to the quantity of this carbonic acid so formed and so evolved.

The circulation is rendered more rapid by muscular effort, and diminished by repose. It is more rapid during walking, less so during quiescence and sleep; it is reduced to its minimum, physiologically, during the continued sleep of hibernation. The rapidity of the respiration is *proportionate* to that of the circulation in all these conditions.

The circulation *without* respiration would be a *self-* or *blood-* poisoning process; respiration is *de-poisoning*. By respiration the carbonic-acid poison formed during the circulation is eliminated from the blood and evolved from the system. Its *final* purpose requires that it should be, what it is, *proportionate* to the circulation. The carbonic acid, when evolved from the blood, no longer a poison, excites the respiration, which conveys it from the system—a wonderful adaptation of the means to the end!

In the state of hibernation, or extreme quiescence, the velocity of the circulation is reduced to its minimum; that of the respiration is *proportionately* reduced.

In the state of extreme activity, the velocity of the

circulation is augmented to its maximum : whilst that of the respiration is *proportionately* augmented.

In the intermediate conditions of animal life, intermediate phenomena of circulation and of respiration are observed.

These interesting phenomena are thus readily explained. The *excitant* of ordinary respiration is the carbonic acid gas, evolved by the blood circulating in the fine membranes of the air-cells, and diffused into the contiguous atmospheric air. This evolution of carbonic acid from the circulating blood is proportionate to the rapidity of the circulation ; and since this carbonic acid gas is the excitant of the respiration, the rapidity of the respiration becomes proportionate to that of the circulation in its turn.

It is demonstrated by chemical analysis that the quantity of carbonic acid evolved is really augmented with the augmented rapidity of the circulation. When the rapidity of the circulation and the quantity of evolved carbonic acid are greatly augmented, the respiration becomes *panting*—a phenomenon observed when, without augmented circulation and evolution of carbonic acid, this latter gas is added in a certain proportion to the atmospheric air respired.

But that carbonic acid which, being evolved, thus performs a most important and vital function, becomes, if retained in the blood, as in suspended respiration, a deadly poison, as I shall proceed to show in the following sections ; and as the quantity of the carbonic acid is

augmented by every acceleration of the circulation, the rapidity of that process of poisoning in apnœa is proportionately great.

§ IV.—*The Rationale of the Effects of Suspended Respiration.*

The phenomena of life result from the play of arterial blood on the nervous and muscular tissues.

The blood is supplied by the ingestion of food, and purified by the egestion of the fæces and urine. It is arterialized by the inhalation of oxygen and the exhalation of carbonic acid in respiration.

Respiration consists in these two processes ; both of which are suspended when the respiratory movements are suspended, as in drowning or strangulation.

These two processes are of very different immediate value to life : the inhalation of oxygen may be long *nearly* suspended without proving fatal ; the suspension of the exhalation of carbonic acid, even if incomplete, destroys life in a comparatively very short time. These facts are demonstrated by the following experiments :

Experiment 1. I placed an animal in a limited portion of nitrogen gas, which, from our imperfect mode of procedure, must have become mingled with a small portion of atmospheric air : it continued to breathe with freedom, only beginning to *pant* as the exhaled carbonic acid began to accumulate.

In *perfectly* pure nitrogen or hydrogen gas, the animal dies more speedily even than when submerged under water—the oxygen already in the blood being probably exhaled. The spark of life becomes almost instantly extinct, with phenomena which are quite peculiar, assuming the form of violent convulsive movements.

One of the most extraordinary results of my experiments is this: a mouse will *live* in an atmosphere of nitrogen and oxygen, in which there is *so little* oxygen, that a lighted taper is immediately extinguished, flame and spark,—and *die* in an atmosphere of carbonic acid and oxygen, in which there is *so much* oxygen, that a taper blown out, leaving a spark, is immediately re-inflamed. It is not the want of oxygen, but the excess of carbonic acid, which proves fatal.

Exp. 2. We placed an animal in carbonic acid: it began to *gasp* almost immediately, and soon expired.

In the first experiment, the inhalation of oxygen was nearly excluded; in the second, the exhalation of carbonic acid was intercepted.

During the physiological condition of the functions, oxygen is continually inhaled, and carbonic acid exhaled. The former unites with the carbon in the blood and *forms* the latter. The carbonic acid, if retained, becomes a deadly poison. The blood, during its circulation, if respiration be suspended, proves *self-poisoning*, by the carbonic acid so formed and retained. This process of self-poisoning is rapid in proportion to the rapidity of

the circulation ; a fact which explains many of the phenomena of apnœa, and of the effects of our supposed remedies.

The process of self-poisoning of the blood from the suspension of respiration is readily traceable in experiment :

Exp. 3. We submerged an animal in water, and carefully watched the phenomena : there were, during the *first* period of submersion, *voluntary* efforts to escape ; then, a *second* period of stillness, or *anæsthesia*, without attempts either to move voluntarily or efforts to respire, the retained carbonic acid poisoning the *brain*, and not escaping into the air-cells ; then followed a *third* period, of *gasping*, which I propose to designate *pseudopnœa*, conjoining opening of the mouth and expiratory movements, with the rejection of foam, resulting from the impression made by the carbonic-acid-poisoned blood on the spinal centre ; at length the gaspings cease, the animal seems to be dead, but a lingering circulation, the value of which is not yet determined by experiment, remains, but quickly subsides into true *asphyxia*.

Exp. 4. Instead of submerging the animal under water, we placed it in a limited portion of atmospheric air (of about three times its own bulk), and observed the following phenomena : the breathing was at the first perfectly natural, unless it was excited by emotion ; during a *second* period it became *panting* or *hyperpnœa*, the exhaled carbonic acid, when re-respired, acting as an undue excitant of the pneumogastric nerves of the pul-

monary air-cells ; this second period passes very gradually into the *third*, or that of *gasping* or *pseudopnæa*, as the carbonic-acid poison formed in the blood excites the spinal centre, a period and a condition further marked by *open mouth*, *starts*, a *tottering* gait, and *paralytic* weakness of the posterior extremities, all denoting affection of the spinal centre.

The third period very gradually passes into the fourth, or true asphyxia and death.

These phenomena proceed with a rapidity which is inversely proportionate to the age of the animal, to its temperature, to its degree of activity, and to its elevation in the zoological scale.

The general principle is further illustrated by the phenomena of submersion in animals in a state of hibernation :

Exp. 5. I submerged a bat, which was lethargic in an atmosphere of 36° Fahr., in water of 40°. It moved about a little, and expelled bubbles of air from its lungs. It was kept submerged during *sixteen* minutes, and was then removed. It appeared uninjured by the experiment !

Exp. 6. I placed a hedgehog which had become so lethargic in an atmosphere of 40° Fahr. as not to awake to take food for several days, under the surface of water at 42° Fahr. It moved about and expelled air from the lungs. It was retained under the water during *twenty-two* minutes. It was then removed. It appeared uninjured !

These animals die as speedily as other warm-blooded animals, if submerged in a state of activity.

Cases are recorded of the human subject being restored after many minutes of submersion. It may well be doubted whether the facts so recorded were correctly observed. But if they were, it must be supposed that a state of *syncope*, or of *shock*, must have obtained at the moment of immersion, and the circulation have been reduced.

For here it may especially be said—*cita mors venit—aut victoria læta*.

The great principle in regard to the duration of suspended respiration without a fatal issue, is—the degree of *slowness* of the *blood-poisoning* process of the circulation. Every thing which, within physiological limits, conduces to this effect, prolongs life. Every thing which, without respiration, promotes the circulation, such as *the warm-bath*, frictions, &c. leads to speedier blood-poisoning and death.

It must be remembered that the blood is poisoned by carbonic acid, formed by and during the circulation, and that there is one remedy, which consists in the elimination of that poison, and that this is—*Respiration alone*.

§ V.—*The Effects of Apnœa chiefly the result of the Retention of Carbonic Acid.*

That the effects of apnœa are not the result of the exclusion of oxygen, but rather of the retention of carbonic acid, has been already stated in general terms, together with *the one sole* efficacious mode of treatment deduced from it. I now proceed to detail experiments, at once full of the deepest physiological interest, and confirmatory of this view.

Exp. 7.—A tame mouse was placed in *two* ounces of nitrogen gas, not quite pure, as before: it soon began to *pant*, from re-respiring the exhaled carbonic acid, and shortly afterwards to *gasp*, from the influence of the action of the retained carbonic acid on the medulla oblongata; and in *five* minutes it was dead.

Exp. 8.—I now placed another tame mouse in *ten* ounces of the same gas: it remained in it during *fifty* minutes, neither panting nor gasping, its breathing becoming slower and feebler. It was removed, and seemed not to have suffered materially. The residual gas instantly and entirely extinguished a taper, flame and spark.

Exp. 9.—In another experiment, I placed a wild mouse in *four* ounces of similar gas. It began to pant in *three* or *four* minutes, and to open its mouth a little in *three* or *four* minutes *more*. It was then transferred into *eight* ounces of fresh nearly pure nitrogen. It remained in this gas *thirty* minutes, its respiration simply

and gradually subsiding in depth and frequency to only forty-eight respirations in a minute. We then removed it, in a most feeble condition; it seemed to recover, however, and the next day was lively; but it died (of secondary apnœa?) on the third.

These experiments are amongst the most remarkable in physiology, and suggest many curious reflections; nearly all the carbonic acid existing in the blood is exhaled; and nearly all oxygen being excluded, little or no further carbonic acid can be formed. Respiration is reduced to its minimum; yet the animal lives, the blood *not* remaining or becoming poisoned by its carbonic acid. It is a condition resembling hibernation.

I reserve further observations on these and another series of experiments for a memoir which I am preparing for the Institute of France. My present object is to present brief *practical* views; my further object is to treat the subject of respiration, and its partial or complete and varied suspension, at greater length and in all its scientific relations.

An animal submerged in water dies very speedily, poisoned by the carbonic acid contained in the blood; and the more speedily, the quicker the circulation and the formation of that carbonic-acid poison. *Gasping* is the premonitory sign of death.

An animal placed in a very limited portion of nearly pure nitrogen gas dies in the same manner, but more slowly, a part of the carbonic-acid poison being evolved into that gas, and *panting* precedes the *gasping*.

In a large portion of nitrogen gas, not quite pure, that is not quite without oxygen, or in a second portion of this gas, the first having received the portion of carbonic acid already formed in the blood, or nearly so, and no further carbonic acid being formed for want of oxygen, the animal, ceasing to experience the organic changes of respiration, and losing its temperature, simply slowly sinks and dies, without the premonitory *panting* or *gasping*.

As natural respiration is the result of excitation of the pneumogastric nerves of the air-cells by the *evolved* carbonic acid; *panting* is the effect of *over*-excitation of these nerves by the carbonic acid *evolved* and by a portion of this gas *inspired*; whilst *gasping* is the consequence of the carbonic acid *retained* in the blood and brought by the circulation into contact with the medulla oblongata and spinalis. None of these events occur in a *large* or *second* portion of nearly pure nitrogen. The carbonic acid formed and evolved becomes less and less, with the gradual subsidence, therefore, of the acts of respiration, for want of the evolved carbonic acid excitant.

The phenomena may be compared to the slow extinction of a taper in a limited portion of atmospheric air.

These views are confirmed by the following experiments in a limited and unlimited portion of oxygen, the difference being the presence or absence of a notable portion of carbonic acid.

Exp. 10.—I placed a white mouse in about two ounces

of pure oxygen gas: it breathed naturally, then panted, then sighed, and then gasped. It was removed in twenty-five minutes, and was slightly convulsed, and still gasped when in the open air; it tottered in its movements. The residual gas brightened the *spark* of a taper lighted and blown out; it therefore contained much oxygen, and the phenomena were exclusively those of carbonic acid.

Exp. 11.—I placed a mouse in a large quantity of pure oxygen gas: it remained during three or four hours without manifesting any change, and was then removed apparently little affected.

§ VI.—*On the Influence of Temperature, and on the Warm-Bath.*

We owe our knowledge of the influence of temperature in apnœa to the splendid investigations of Edwards, and to the more recent experiments of M. Brown-Séquard.

Within certain limits, which may in general terms be fixed at 60° and 100°, Fahr. the duration of life in the case of suspended respiration is *inversely* as the temperature.

Above and below those temperatures respectively, heat and cold have each a directly injurious effect.

In illustration of these facts, I here adduce two invaluable *Tables*, giving the results of the experiments of Edwards and of M. Brown-Séquard:

*Edwards's Table.**

Influence of temperature.—Kittens two days old asphyxiated by immersion in water :

	Mean duration of life.
At 32° Fahr.	4' 33"
50°	10' 23"
68°	38' 45"
78½°	34' 30"
86°	29'
106°	10' 27"

M. Brown-Séguard's Table.†

Influence of *previous* temperature.—Rabbits two days old immersed in water of 77° Fahr. being first cooled :

	Mean duration of life.
To 96° Fahr.	12'
85°	18½'
74°	23'
65°	28'

It is obvious that the continuous warm-bath, taken alone, must be utterly excluded in the treatment of apnœa—that it can only be considered as admissible when respiration is either not extinct or admits of being excited, or is effectually imitated artificially.

There *is*, however, a use, not indeed for the *continuous* warm-bath, but for the *sudden hot-bath*, not

* Des Agens Physiques ; p. 630—.

† Researches, New York, 1853, p. 47.

hitherto suggested for adoption in practice : it is when it is of such elevated temperature, and when the patient is in such a condition, as to admit of its being made an *excitant of respiration*.

Its use in this point of view is chiefly useful in the apnœa of still-born infants ; and I shall have to treat of it in this relation hereafter. But it cannot be doubted that, if it could be made available at the moment the patient is rescued from the water, a sudden momentary plunge into a bath of from 100° to 104° Fahr. would prove the most powerful *excitant* of inspiration.

But, even in this case, the application of the hot-bath must be momentary, and *alternated* with that of the cold bath or douche of the temperature of 50° or 60° Fahr. as an *excitant* of respiration in its turn.

This suggestion I made some years ago to my much-lamented friend, Mr. Henry Smith, who, in one case, the only one on record, used it in the case of a still-born infant, with complete success.

We must cease therefore from the empirical use of the warm-bath. When this agent is used, it must either be administered as an excitant, not of the circulation, but of respiration ; or as an excitant of the circulation, respiration being already restored, excited, or adequately imitated.

In confirmation of these results, I may here adduce four experiments, performed at the Royal Humane Society's receiving house in Hyde Park, and witnessed and recorded by Mr. Williams, its superintendent :

Exp. 12.—A kitten, three days old, 98° Fahr. in temperature, was submerged in water of the same temperature. Its last gasp was at the termination of 14½ minutes.

Exp. 13.—A kitten of the same age, after exposure alone to the cool atmosphere, was immersed in water of 50° Fahr. It survived 23 minutes!

Exp. 14.—We submerged a puppy, 66 hours old, under water at 100° Fahr. It endeavoured to escape; became still; then continued to gasp, frequently and quickly, during 19' 35": we counted 16 gasps.

Exp. 15.—We submerged a puppy of the same litter in water of 50° Fahr. It endeavoured to escape; became still, but in a less marked manner than the former one; gasped more slowly and at longer intervals during 39' 35"! In this case we counted 24 gasps.

Judging from the *Table* of Edwards, the animal would have lived longer still in a temperature of 60° Fahr.; this temperature acting in prolonging life in apnœa, whilst that of 50° destroys life as the direct effect of cold.

§ VII.—*The former Modes of Treatment of Asphyxia.*

The modes of the treatment of asphyxia hitherto proposed cannot be stated more distinctly than by the subjoined quotation of the latest *Rules* proposed by the Royal Humane Society :

“ To Restore the apparently Drowned.

“ 1. Convey the body carefully, with the head and shoulders supported in a raised position, to the nearest house.

“ 2. Strip the body and rub it dry ; then wrap it in *hot* blankets and place it in a *warm bed*, in a *warm chamber* free from smoke.

“ 3. Wipe and cleanse the mouth and nostrils.

“ 4. In order to restore the natural *warmth* of the body—move a *heated* covered *warming pan* over the back and spine.

“ Put bladders or bottles of *hot water*, or *heated bricks*, to the pit of the stomach, the arm-pits, between the thighs, and to the soles of the feet.

“ *Foment* the body with hot flannels.

“ Rub the body briskly with the hand ; do not, however, suspend the use of the other means at the same time ; but, if possible, immerse the body in a *warm-bath* at blood heat, or 100° of the thermometer, *as this is preferable to the other means for—restoring warmth.*

“ 5. Volatile salts or hartshorn to be passed occasionally to and fro under the nostrils.

“ 6. No more persons to be admitted into the room than is absolutely necessary.”

These *Rules* may be summed up in one word—*warmth!* The idea is repeated no less than eight times.

In addition to these measures, others are also recommended, and especially Leroy's mode of inducing artificial respiration by means of a bandage, so applied to the thorax as to admit of being tightened and relaxed.

§ VIII.--*Reflections.*

But it will be sufficiently obvious to those who have read the preceding pages with attention, that our main objects in treating asphyxia are *two*: 1, to eliminate the carbonic-acid poison already formed in the blood; and 2, to check as far as possible its further formation.

The utility of an emetic, as the *first* means of treatment in stomach-poisoning, is not more obvious than the instant institution of artificial respiration, the sole eliminator of the blood-poison, in apnœa; and as in the former we would not administer a new dose of the poison, so in the latter we must not, if we could, prematurely accelerate the circulation of the blood—that is, the *formation* of additional poison, by warmth, the *warm-bath*; &c.

Without due artificial respiration, every means of augmenting the circulation must be injurious. Excited or imitated respiratory movements are the sole means of eliminating the carbonic-acid poison from the blood—the *unicum remedium* in apnœa; and whatever part the want of oxygen plays in the state of things which exists in apnœa, in addition to the excess of carbonic acid, it is still by respiration alone that it can be supplied. The warm-bath and the other measures for restoring the cir-

culation, *without this* as the *constant* and *preliminary* measure, if they have any influence at all, *can* only augment the formation of the poison.

These latter measures must therefore be delayed. The *first*, the *sole first*, remedy is—artificial respiration.

But the modes hitherto proposed for the institution of respiration are, for reasons which I proceed to give, either inefficient or absolutely injurious.

These modes of inducing artificial respiration are of two kinds: the *first* may be compared, in its operation, to the action of the *forcing-pump*; the *second*, to that of the *suction-pump*; and both have been used with a disregard to the all-essential consideration of *posture*.

To commence my observations on this *last* point, I must remark that when the subject is kept in the *supine* position, events occur which render *every* attempt at inducing respiration absolutely nugatory: *the tongue may fall backwards, carry with it the epiglottis and close the glottis or entrance into the windpipe and air-passages! Fluids already in the mouth and fauces, or regurgitated from the stomach, may not only obstruct the air-passages, but be forced or drawn into the windpipe, and so add a new source of apnœa?*

These obstacles are obviated at once by reversing the position from the *supine*—to the *prone*!

Mr. Williams, the Society's Superintendent in Hyde Park, has observed the cheeks to become inflated and air to escape from the intestine, in cases in which artificial

respiration has been attempted by the bellows ; and it is certain that the plan of Leroy can have little efficacy.

The following experiment has been repeated many times, and has been witnessed by George Webster, jun. Esq. of Peckham, Mr. Williams, and other gentlemen :

Exp. 16.—The dead subject being placed in the *supine* position, and pressure made on the sternum and ribs, a little gurgling was heard in the throat ; but, the pressure being removed, there was *no* evidence of *inspiration*. The subject being then turned into the *prone* position, and pressure being made on the spine and the ribs, and removed as before, there was in general free *expiration* and *inspiration*.

One object of the succeeding section will therefore be to describe and recommend the plan of *prone*-respiration, or PRENOPNŒA (from *πρηνης*, pronus).

But another objection applies to the mode of inducing artificial respiration having the character of the forcing-pump.

In order to accomplish this kind of respiration, a degree of force must be used, sufficient to raise the bony and other structures of the thorax, and depress the diaphragm—a degree of force which both anticipation and experience prove to be injurious to the delicate structure of the lungs. Legallois and M. Leroy found these structures variously lacerated by this measure in experiments on animals—the air so impelled sometimes passing into the capillary vessels, and sometimes even into the cavity of the thorax !

Two facts are obvious from the considerations laid before the reader in this and the preceding sections: the first, that artificial respiration must precede and accompany all other measures for the recovery of the patient affected by the suspension of this vital function; and the second, that some other modes of artificial respiration than those hitherto proposed must be devised, before we can be said to treat the case on scientific grounds, or in a safe and efficient manner.

I must add, that any measure of inducing the artificial inspiration of air, if used with too great *rapidity*, is apt to close the larynx by external pressure on its sides:

Exp. 15.—I removed the larynx and windpipe, and attached the nozzle of the syringe to the lower part of the latter: on drawing up the piston, the cordæ vocales were seen to be drawn together whenever the piston was moved with some degree of rapidity, and all ingress of air into the windpipe utterly prevented!

The obvious conclusion is, that, whenever we attempt artificial respiration, the procedure must be effected with gentleness and slowness.

§ VIII.—*New Modes of Treatment of Apnœa.*

The reader of the preceding section will readily anticipate the principal points in this.

The patient is to be taken from his former supine position and laid *prone on his face*.

In this position, the tongue falls forwards, draws with it the epiglottis, and leaves the glottis open, whilst all fluids will flow from the fauces and mouth. The tongue may even be drawn forwards, to secure its removal, and that of the epiglottis, from the rima glottidis.

In order that the face may not come into contact with the ground, the patient's wrist is to be carried upwards and placed under the forehead.

It will now also be perceived that the thorax and abdomen will be pressed by a force equal to the weight of the trunk. This pressure will induce *expiration*. And, additional pressure being now made on the posterior part of the thorax and abdomen, the expiration will be more complete.

This latter pressure is to be then removed. Its removal will be followed by slight *inspiration*. The weight of the body is then to be removed from the thorax and abdomen, by gently turning it *on the side and a little beyond*, placing one hand under the shoulder and the other under the hip of the side moved. In this manner a fair degree of *inspiration* is induced! *And thus, without instruments of any kind, and with the hands alone, if not too late, we accomplish that respiration which is the sole, but sure effective means of the elimination of the blood-poison!*

For some experiments on this mode of inducing artificial respiration, which I designate *postural* respiration, or THESIOPNŒA (from *θεσις*, positio), I am indebted to Edward Long Fox, Esq. of Bristol. They were per-

formed by that gentleman, with the aid of Mr. Charles Hunter and Mr. R. L. Bowles, at St. George's Hospital.

Exp. 17.—"The recently dead body was placed in the *prone* position; as this was done, considerable expiration took place. Pressure being made on the back and ribs, further expiration took place, but only to a slight extent. On removing this pressure, slight inspiration took place. On turning the body on the left side, violent inspiration took place, which ceased as the body was turned beyond the quarter of a circle.

"The body was again pronated and again rotated. The expiratory and inspiratory effects were most marked. On one occasion, 120 bubbles of air (in a bent glass tube through which the patient breathed) were distinctly counted during one expiration; and the inspiration seemed to be quite in an equal degree, although, from its greater rapidity, the bubbles could not be counted."

Exp. 18.—"The body was turned into the *prone* position: considerable expiration took place, which was much augmented by the pressure of the hands on the back. On removing the pressure, a little inspiration took place. The body being then rotated on the right side, considerable inspiration took place, whilst moving through one fourth of a circle; on continuing the rotation, inspiration continued until the body was half way between the table and the lateral position, when it ceased."

Exp. 19.—"The subject, a girl, aged 5 years. On

pronation of the body, air was expelled in considerable quantity through the water in the inverted glass siphon. On rotation, air entered to a corresponding amount. This was repeated 7 or 8 times."

The efficacy of rotation was again manifested in a subsequent experiment witnessed by Mr. Williams.

Exp. 20.—In some experiments made at the St. Mary-le-bone Infirmary, already noticed, the dead subject being first placed on the *back*, and pressure made on the thorax, a little expiratory noise was made; but there was no inspiration on its removal; the subject being turned *prone* on the face, *both* expiration and inspiration were distinctly observable on making and removing pressure along the course of the dorsal spine.

This manœuvre must therefore be *added* to rotation: when the patient is laid quite *prone*, gentle pressure may be made on the spine and ribs; this being removed, the patient may be *rotated*; and so on systematically.

These changes should be alternated at the rate of about *sixteen* times in a minute, and *not more*, and gently and equably.

It is scarcely necessary to add that this mode of respiration must be long and perseveringly pursued; and now that respiration is being accomplished, every other means of respiration *may be superadded*.

Sufficient has been done to show the practical utility of this, the only certain, safe, and efficacious mode of inducing artificial respiration; but it is obvious that it

still remains to ascertain the exact *value* of this and of other measures for succouring the patient affected by apnœa, not by what is fallaciously called experience, but by a series of careful and *comparative experiments*.

The clothes of the patient may meantime be changed for others warm and dry, which must be contributed by the bystanders. For I must now observe that I have all along supposed the patient taken out of the water at a distance from medical or other assistance, except that which benevolent persons accidentally near the spot may be able to afford; for no time must be lost by his removal.

All who are so present should be instantly employed: the most able in effecting respiration; of the rest, *four* should sieze the limbs with their hands and rub them with firm pressure upwards. The warm-bath is not to be compared with this mode of restoring warmth and improving the circulation, if it be pursued with energy. The blood is driven upwards, and though at first venous, *may* stimulate the heart.

But I must repeat that all these modes of procedure must be held as perfectly *subsidiary* to the one only remedy, *prone and postural respiration*. There is one hope, and only one hope; one remedy: it consists in eliminating the carbonic acid blood-poison from the blood by respiration.

Having thus given in detail my views of former modes of procedure and of some new ones, I now proceed to place before my readers a recapitulation of the

treatment to be systematically adopted in apnoea, in the form of *Rules*, which, I humbly think, may with great advantage be substituted for those formerly recommended:

§ IX.—*New Rules for the Treatment of Asphyxia.*

The *Rules* for the treatment of asphyxia may be divided into two series :

1. The essential, or the means to be adopted in every case ;
2. The occasional, or the means to be further tried when convenient.

I. *Rules to be adopted in every case :*

I. Send with all speed for medical aid, articles of clothing, blankets ; &c. but

II. *Lose not a moment of time ; treat the patient on the spot, in the open air, exposing the face and chest freely to the breeze (except in too cold weather) ; then—*

To excite Respiration—

III. Place the patient gently and for a moment on the face, to allow any fluids to flow from the mouth ;

IV. Then raise the patient into the sitting posture, and endeavour to *excite* respiration—

1. By irritating the nostrils by *snuff*; *hartshorn*; &c.
2. By irritating the fauces by a *feather*; &c.
3. By dashing hot and cold water alternately on the face and chest. If these means fail—

To imitate Respiration—

V. Replace the patient on his face, his wrist under his forehead (*vide* frontispiece), and—

1. *Turn* the body gradually, but completely, on the *side*, and a *little more*; and then again on the face, alternately;
2. When replaced; apply pressure along the back and ribs, and then remove it, and proceed as before;
3. Let these measures be repeated gently, deliberately, but efficiently, and perseveringly, *sixteen* times in the minute, *only*.

VI. *Continuing* these measures, rub all the limbs upwards, making firm pressure, *energetically*.

VII. Replace the wet clothes by such other covering, &c. as can be procured.

Omit the warm-bath until respiration be re-established.

II. *Further Rules, to be adopted when convenient:*

I. Apply galvanism ;

1. Along the diaphragmatic nerve, or
2. Through the diaphragm and intercostal muscles ;

II. Induce the inhalation

1. Of oxygen ;
2. Of dilute pure ammonia.

On the first part of these Rules no further explanation is necessary. On the second, I now propose to make a few concluding observations.

Of the value of galvanism I have not formed a very high opinion. If the current be passed along the diaphragmatic nerve, or through the diaphragm itself, or through the intercostals, respiratory movements may be excited. But I do not know that they would possess any advantage over similar movements induced in any other way.

It is still a question whether the action of the heart may be beneficially excited by galvanism. But the careful experiment should be tried.

The galvanic current passed through the limbs would excite their muscles to contract, and so induce the propul-

sion of the blood along the veins. Whether this mode of promoting the venous circulation would possess any advantage over the mode by friction and pressure, requires to be determined by experiment.

I cannot regard the inhalation of oxygen as a very promising measure. Its value requires to be submitted to *much* further trial and investigation.

The inhalation of dilute pure ammonia appears to me to have more in it of promise. The blood is overcharged with carbonic acid : the inhalation of ammonia would neutralize this carbonic acid and form the carbonate of ammonia ; the carbonic acid is the blood-poison ; the carbonate of ammonia is free from any deleterious quality.

It cannot be repeated too often or too earnestly that all these remedies of the second class, if I may so designate them, must be regarded as entirely subsidiary to the constant persistence of respiration.

The Warm-Bath.

It will be seen that I have entirely omitted the use of the warm-bath.

This measure is perfectly useless, not to say injurious, unless artificial respiration be simultaneously administered ; and this administration is incompatible with the posture implied by the use of the warm-bath. *To use the warm-*

bath is, therefore, to renounce the only hope, the only remedy in apnœa.

It is true that the warm-bath has been commended by some of the members of the Royal Humane Society ; but it is as emphatically condemned by the Superintendent of the Society at Boulogne, by theory, and by experiment.

Experiment proves, as seen in the *Tables* adduced (pp. 18), from Edwards and M. Brown-Séquard, that life is more protracted in the case of suspended respiration at cool temperatures than in temperatures more elevated ; and the experiments given, p. 19, 20, were performed at the Receiving House in Hyde Park, the first two being witnessed by the Secretary of the Society and by Dr. Christian.

An animal lives longest *without* respiration in a temperature of about 60° Fahr. With respiration, the temperature may be carefully raised to 98°.

§ X. *On the Apnœa of Still-born Infants.*

The difference in regard to the power of supporting the suspension of respiration in the young animal *before* and *after* the commencement of respiration has been noticed by the illustrious Harvey, by Buffon, by Legallois, by Edwards, &c. The same difference obtains in regard to the very young and the less young of certain species of animals which have breathed.

We all remember the celebrated question of Harvey, and the equally celebrated experiment of Buffon. The fœtus breathes less, developes less heat, and supports suspension of respiration better than the infant. It supports apnœa proportionably longer.

The differences in regard to age in rabbits is shown in the following beautiful *Table* of Legallois :

Legallois' Table.

Influence of age upon the duration of life. Rabbits asphyxiated by immersion in water.

Days old.	Sensibility*.	Gaspings.
1	15'	27'
5	10'	16'
10	4½'	5½'
15	3'	4'
20	2¾'	3¼'
25	2'	2¾'
30	1½'	2½'

The same fact is observed in puppies and kittens. The guinea-pig is, however, an exception to the rule;

* Legallois observes (Ed Paris, 1812, p. 79)—J'essaye la sensibilité en pinçant les oreilles, les pattes et la queue, et j'en note l'extinction au moment où ces pincements ne déterminent plus aucun mouvement." "Assez souvent il existe encore un peu de sensibilité à l'anus, quand il n'y en a plus dans ces parties."—Phænomena, in fact, not of sensibility, but of reflex action.

the very young of this species holding nearly the same rank in this respect as the adult.

In regard to the human subject, we learn from the experiments of MM. Andral and Gavarret that the *quantity* of carbonic acid exhaled in respiration *increases* from the age of eight to that of thirty years; apnœa will of course be the more promptly fatal in the inverse order. After the age of thirty, the quantity of the carbonic acid poison *decreases*.

The male subject exhales more carbonic acid than the female, the robust than the feeble, and will consequently perish more promptly by the suspension of respiration; a result the opposite, I believe, to the popular opinion.

In treating the still-born, the first great object is, as usual, to *excite* respiration; this is *most* effectually done by plunging it into a *cold* (—not a *warm* bath—) and a *hot* bath alternately. This means of exciting respiration in the still-born infant was first put to the test of experiment, at my suggestion, as I have already stated, by my late deeply regretted friend, Mr. Henry Smith.

The just temperatures of these baths have not yet been ascertained. I would suggest from 50° to 60° Fahr. for the cold, and from 98° to 102° Fahr. for the hot bath. The immersion should be momentary; the alternations quick.

If this means fails,—if irritation of the nostrils, the face, and the general surface, has been tried in vain—*not a moment is to be lost*, but respiration must be *imitated* in

the manner already described—the *prone* position being first adopted, and then *postural*-respiration being fully and perseveringly instituted.

§ XI.—*On Secondary Apnœa.*

All is not safe even when the patient seems to be restored from apnœa.

One of the puppies of Buffon's experiment died some time afterwards on the same day.

On one occasion I placed a sparrow and a mouse in the same limited portion of atmospheric air. After a time, the sparrow began to open its mouth and gasp, and was removed; and after a longer interval, the mouse presented the same phenomena, and was removed in its turn. The bird died the next day; the mouse on the second following day—of secondary apnœa.

Sir Humphry Davy was seized with alarming symptoms on the evening of the day on which he had attempted to breathe carburetted hydrogen gas.

On one occasion a soldier was taken out of the Thames in a state of apnœa. Animation was restored. But, many hours afterwards, he was seized with convulsions and expired.

From these and other similar facts we must deduce the conclusion, that our watchful care and our remedies must be continued after apparent danger is over. There is still a *hidden* and remoter danger; the consequence of the poisoned state of the blood—of *secondary* apnœa.

The patient should be *kept* in a cool atmosphere, *exposed* to the breeze, and be *made* to take deep and free inspirations voluntarily, and active exercises should, as far as possible, be enjoined, in order that the blood may be purged of its carbonic-acid poison, whilst its circulation is promoted. Carbonic acid *in the blood* does not excite respiration until it exists in sufficient quantity to induce gasping by acting centrically on the spinal marrow. It is its presence in the air-cells which induces inspiration and panting, as a *reflex* phenomenon. Its elimination, therefore, requires voluntary, excited, or artificial respiratory movements.

But the specific antidote to this blood-poison is—the free inhalation of dilute pure ammonia. This gas actually *neutralizes* the carbonic poison in the pulmonary blood.

§ XII.—*Recapitulation.*

1. The movements in normal respiration are *reflex* or *diastaltic*;

2. The respiratory movements in apnœa are *direct* or *ecstaltic*;

3. The *former* are excited by the carbonic acid exhaled from the blood into the air-cells, in contact with the filaments of the pneumogastric nerve; and

4. When this carbonic acid is in excess, it induces *panting*;

5. The *latter* are excited by the carbonic acid *retained* in the blood and brought into contact with the medulla oblongata and medulla spinalis ;

6. They take the specific form of *gasping*, with jerks and tottering movements, and eventually of paraplegia ;

7. The carbonic acid retained in the blood acts as a most deadly *poison* ; there is ONE mode of eliminating this poison,—Respiration,—and one sure mode of inducing respiration—*pronation and rotation* of the body.

*Respiration is to the Carbonic-Acid Poison in the Blood,
what Vomiting is to Poison in the Food.*

8. The quantity of this carbonic-acid poison formed is proportionate to the rapidity of the circulation ; to augment the circulation *without* effecting the elimination of the poison by artificial respiration, as by the warm-bath, is to augment the quantity of the poison, and to accelerate the death of the patient !

9. In order to effect artificial respiration, it is essential to place the patient in the *prone position* ; otherwise the tongue and any fluid in the mouth fall backwards and close the glottis or entrance into the windpipe ;

10. In adopting the prone position, a degree of pressure is at the same time made on the thorax and abdomen equal to the weight of the trunk of the body, and *expiration* is produced ;

11. A little pressure now made along the spine augments the expiration ;

12. On removing this pressure, *inspiration commences* ;

13. And by gently *rotating* the body on the side, *further inspiration occurs* :

14. By repeating these manœuvres we produce *the most efficient artificial respiration—the only effectual means of treatment ; they have never failed us !*

15. When artificial respiration is thus effected, and the carbonic-acid poison is thus eliminated from the blood, the application of friction with pressure along the veins, and of warmth, may be superadded ;

16. The *warm-bath*, excluding *prone* and *postural* respiration, should only be administered when the respiration is either not suspended, or when it is perfectly restored.

Lastly, I must repeat that the foregoing pages are a mere Abstract of a considerable investigation scarcely more than just begun. Much remains to be done.

§ XIII.—*The Royal Humane Society.*

Such is very nearly the Essay which I presented, first in manuscript and then in print, to the Royal Humane Society, in January, 1856, and of which the following notice occurs in the Society's Report :

“ Dr. Marshall Hall, a Member of the Committee,

has just presented to the Society a manuscript copy of a 'Treatise on Asphyxia; being an abstract of an investigation of its nature, carbonic-acid blood-poisoning, and its remedy, prone and postural respiration.' He is also having it printed at his own expense, with a view of supplying the Committee with a sufficient number of copies for the purpose of being sent to all the Medical Assistants of the Society; for which he has received the thanks of the Committee, for the lively interest he has thereby evinced in the objects of the Society."—*Report*, p. 24.

I earnestly requested that a sub-committee might be appointed to witness the development of the beautiful results of postural respiration—but in vain!

Mr. Williams once witnessed an experiment at St. George's Hospital, and I add his account of it; it was made *before* the *Pnæometer* used in the subsequent experiments was invented. The apparatus consisted of an elastic tube, furnished with an inverted siphon containing a little water, to indicate the flow and reflux of the air, induced by rotation and pronation.

" Attended at St. George's Hospital, to witness some experiments made on the new method of producing artificial respiration without the aid of bellows, proposed by MARSHALL HALL, M.D. &c.

" The mouth and one nostril were carefully closed by means of sticking-plaster, to prevent the possibility of

air finding its way through them. In the other nostril was inserted a caoutchouc tube, about three feet long, at the end of which was fixed a bent glass tube of the same size, into which was poured a teaspoonful of water.

“ The operator then took hold of the subject (which was lying in the prone position) by the left shoulder and hip, and gently raised it, until the whole body was resting on the right side. This movement caused the air to enter the glass tube, creating bubbles in the water as it passed on into the lungs ; and on the body being slowly replaced on the stomach, the air was freely expelled from the lungs, and caused the same agitation in the water as it made its exit through the glass tube.

“ Judging from the agitation of the water, the quantity of air which passed into the lungs must have been considerable, and quite sufficient for the purpose of artificial respiration.

“ The great advantage of inflating the lungs by means of the rotatory movement, or raising the body by the one shoulder and hip, is the readiness with which one person can perform the operation, in the absence of any other assistance.

“ This experiment appeared to be perfectly satisfactory.

“ HERBERT WILLIAMS,

“ Superintendent R. H. S. Hyde-park Receiving-house.

“ Feb. 6, 1856.”

PART SECOND.

IF OUR PATIENT BE DYING FROM COLD, DO WE NOT CAUTIOUSLY ADMINISTER WARMTH? OR IF HE BE READY TO PERISH FROM WANT OF FOOD, DO WE NOT ADMINISTER FOOD? AND SHOULD HE BE IN PERIL FROM WANT OF AIR, SHALL WE NOT ADMINISTER AIR? WOULD THE WARM-BATH SUPPLY THE PLACE OF FOOD? NEITHER CAN IT SUPPLY THE PLACE OF AIR.

PART SECOND.

POSTURAL RESPIRATION

IN

DROWNING,

ETC.

§ I.—*The Royal Humane Society.*

A YEAR has rolled round, and the Report of this Society for 1857 contains the following paragraph :

“ The Governors will remember that in last year’s Report it was announced that Dr. Marshall Hall had presented to the Society a new Treatise on “ Asphyxia,” of which work he subsequently presented to the Society a sufficient number of printed copies to enable the Committee to transmit a copy to each of the Society’s Medical Assistants, and which they accordingly did, accompanied by a circular letter calling on each to give his opinion on the proposed new methods of treatment. Ten replies thereto have been received, including one from Sir Benjamin Brodie, and one from Dr. Christian, M.D. acting Surgeon to the Society’s Receiving House, Hyde Park ; and from the preponderating opinions gathered therefrom, the Committee are advised to pause before adopting this new method recommended by Dr.

Marshall Hall, until it has been proved by the test of successful experience.”—*Report*, p. 27.

Any thing more insidious could not be penned !

And on what question, in reality, does the Committee pause ? Their patients are dying for want of respiration ; the safe and effectual means of administering this respiration are placed in their hands ; and they pause as to whether they will allow the patients to use them !—as to whether they will allow the patient dying for want of air to have air administered to him !

The *delay* is *homicidal*.

There is no need of a “successful experience” in a matter so simple ; but if there were, it *has been* afforded by the cases recorded in the LANCET during the year which has intervened between the dates of the Society’s two Reports.

It is a question for unsophisticated common sense.

But what are those untoward reports ? Why are they not published ? It is surely a question in which the public and the profession are deeply concerned.

Dr. Christian, acting Surgeon to the Society’s Receiving House, Hyde Park, is mentioned as one having sent in a report. But it was Dr. Christian who proposed *first* to try “removal, the warm-bath, and galvanism ;” and *then*, when the apnoea, however hopeful, *must* have passed into hopeless asphyxia, to institute postural respiration !

Dr. Christian introduces the following *new* Rule I, without acknowledging its author :

“ *Lift the body out of the water*” (of the warm-bath), “ *the neck and chest being bare, and dash cold water suddenly against the face, neck, and chest.*”

This is the *alternate* application of heat and cold, which was first proposed by me, and first carried into effect by my friend Mr. Henry Smith, in the treatment of the still-born infant, and given in the Essay presented to the Society, in the following terms :

“ There *is*, however, a use, not indeed for the warm bath, but for the *hot* bath, not hitherto suggested for adoption in practice : it is when it is of such elevated temperature, and when the patient is in such a condition, as to admit of its being an *excitant of respiration*.

“ Its use in this point of view is chiefly useful in the asphyxia of new-still-born infants ; and I shall have to treat of it in this relation hereafter. But it cannot be doubted that, if it could be made available at the moment the drowned patient is rescued from the water, a sudden momentary plunge into a bath of from 100° to 104° Fahr. would prove the most powerful *excitant* of inspiration.

“ But, even in this case, the application of the hot-bath must be momentary, and *alternated* with that of the cold-bath of 50° or 60° Fahr. as an *excitant* of respiration in its turn.

“ This suggestion I made some years ago to my much-lamented friend, Mr. Henry Smith, who, in one case, the only one on record, used it in the case of a still-born infant, with complete success.

“ We must cease therefore from the empirical use of the warm-bath. When this agent is used, it must either be administered as an excitant, not of the circulation, but of respiration ; or as an excitant of the circulation, respiration being already restored, excited, or adequately imitated.”

I dismiss this very painful subject by adducing Dr. Christian’s proposition entire, leaving it to the judgment of my readers :

“ Rules for treating Persons Asphyxiated.

“ 1. Convey the body rapidly to the house, the head and shoulders raised.

“ 2. Place it at once in the warm bath at 100°, up to the neck.

“ 3. Lift the body out of the water, the neck and chest being bare, and dash cold water suddenly against the face, neck, and chest.” (See above, p. 47, l. 1.)

“ 4. Pass pure ammonia under the nose.

“ 5. Use artificial respiration, the patient being held in the upright position.” (How ?)

“ 6. Pass the galvanic current through the chest, including the diaphragm and the muscles of respiration.

“ 7. These methods should occupy but a few minutes (!) ; if they fail, place the patient on the floor” (why on the *floor* ?), “ and use the ‘ Ready Method’ according to the printed directions, fully and efficiently.” (!)

But it must be remembered that nearly the first lines of that ready method are—

“ *Lose not a moment of time, treat the patient on the spot, in the open air, exposing the face and chest freely to the breeze.*”

As to our “experience,” I must observe that there are *four* distinct stages of apnœa :

1. The *first*, that in which there are still slight signs of respiration ;
2. The *second*, that in which respiration has entirely ceased, but may be *excited* by proper *excitants* ;
3. The *third*, that in which no excitant can excite respiration ; and
4. The *fourth*, true asphyxia.

It is absolutely necessary to keep these distinctions in view, in judging of the efficacy of remedies, in order that we may compare *similar* cases ; and this has never been done. Our “experience” therefore is a *fallacy*.

If this were done, it would still be necessary to compare *similar* cases in sufficient *number* ; and this has never been done, and indeed probably never will be done ; again therefore our pretended “experience” is a *fallacy*.

And thus it has happened that the continuous warm-bath, which *must* be injurious, has been *supposed* to be beneficial !

But I proceed to details of far greater weight and importance than this very useless controversy.

§ II.—*More detailed Rationale of Apnœa.*

Before we can be perfectly prepared to investigate the nature of apnœa, its effects, and its remedies, we must study the special function which is interrupted.

Respiration involves *four* important processes :

First ; oxygen is *absorbed* by the blood circulating in the pulmonary blood-channels,—only absorbed,—from the *inspired* atmospheric air.

Secondly ; by this oxygen the carbonic acid is displaced and evolved from the blood, and removed from the system with the *expired* air.

Thirdly ; aqueous vapour in large quantity is evolved from the pulmonary blood, and exhaled with the same expired air.

Fourthly ; the expired air has a higher temperature than the inspired air ; caloric is therefore given off by the pulmonary blood, the temperature of which is *pro tanto* diminished :—respiration is therefore a *cooling process*.

The *panting* of the dog from excessive heat is doubtless a cooling process, and its final object to keep down the temperature.

The cooling effect of artificial respiration led in certain experiments to erroneous conclusions in regard to the source of animal heat.

The trachea is not only the way of ingress into the lungs, but the way of egress from the lungs ; it is not

only the ventilator by which the atmospheric air, and especially its oxygen, is admitted, but the chimney by which the air expired is, with its accession of carbonic acid, conveyed from the lungs,—that carbonic acid which would, if retained, be a real “*choke-damp*,” as it is the blood-poison, and the real cause of death, in apnœa.

The important function of respiration consists in this inhalation of oxygen and exhalation of carbonic acid. This function is unattended by any important change of temperature. Animal heat is evolved *not* in the lungs, *but* in the general system at large, where the change of oxygen into carbonic acid, the slow *combustion* of carbon, takes place, during the processes of deposition and absorption in which nutrition consists.

That nutrition, and with it the evolution of heat, are events which occur in the *systemic* circulation, are facts principally established in modern times ; but not entirely ; they were not unknown in the time of Harvey. I find the following remarkable passage in a “Discourse” appended to his English edition of Harvey’s “Anatomical Exercises concerning the Heart and Blood,” by Dr. James de Back, which appeared in the year 1653, p. 107 :

“ I doe believe, that wherever nutrition is performed, there this function is most manifestly executed, and that the parts, whilst they are nourished, are *heated* ; there the composition of the blood is dissolved, and is divided very small ; there also the *firie particles*, freed from their fetters, and being united, do show their force by heating.”

That the function of respiration is in reality a cooling process, was the doctrine of Galen (*De Utilitate Respirationis*, ed. Ven. 1597, p. 223). It was also the doctrine of Haller; and it is obviously true. We may inhale the atmospheric air at various temperatures, some of which are below that of freezing water; we exhale it at the temperature of 92° or 94° Fahr.—a temperature comparatively higher even in summer, and still more considerably so in winter. This elevation of temperature in the expired air is effected by a proportionate loss of temperature sustained by the blood circulating in the pulmonary blood-channels. *Respiration* is therefore a cooling process.

We may thus recapitulate the matter: the oxygen inspired in the lungs is absorbed, and thence conveyed by the arterial blood into the general system, and *there supports* the slow combustion of the tissues, by which combustion the animal heat is evolved; the carbonic acid, the choke-damp, the blood-poison, formed by this combustion, is re-conveyed by the venous blood to the lungs, and thence exhaled into the atmosphere.

If the mere absorption of oxygen be attended by the evolution of a slight degree of heat, this is probably counterbalanced by the simultaneous escape of carbonic acid, the one losing, the other assuming, simultaneously, the form of gas; so that the resultant temperature may be unchanged.

But the evolution of aqueous vapour must also be a cooling process in proportion to the quantity of water passing from the fluid state to that of vapour.

The cooling effect of the inhalation of a cooler and exhalation of a warmer portion of air constitutes then an obviously cooling process.

And here I may revert to that marvellous law of the animal economy, according to which the number and extent of the respirations and the rapidity of the circulation constantly maintain a due *ratio* to each other. During repose, and especially during sleep, these are both at a *minimum*; during activity and effort of every kind, they are augmented. In both cases the physiological ratio or proportion between them is sustained.

A singular exception to this rule is observed in the dog, which pants and projects its tongue, as the effect of heat merely, I believe, without proportionally augmented circulation; the augmented respiration is merely a cooling process.

If the due ratio between the circulation and the respiration were broken, one of two events must occur: if the circulation be unduly and disproportionately augmented, or the respiration be unduly suppressed, the quantity of carbonic acid formed being unexhaled and therefore retained, the blood becomes poisoned and the patient destroyed; if the respiration were unduly augmented, the temperature of the animal would be lowered, and the patient might die of *refrigeration*. The former fact obtains in every case of apnœa; it constitutes the death by drowning, strangulation, "choke-damp." The latter fact was actually produced in the splendid experiments of Legallois, in which he used artificial respiration. Undue

artificial respiration cools and destroys : the *balance* of temperature is lost.

In treating the cases of apnœa and approaching asphyxia, these principles must be our guide : if we induce too full and too frequent respiration even, the patient will lose his temperature and be destroyed.

I have already said and proved that a disproportionate circulation is fatal,—that the tendency of the warm-bath without respiration is deleterious.

If our attempts at artificial respiration be made inconsiderately,—if the induced respiration be too rapid or too great, compared with the remaining degree of the circulation,—we destroy our patient.

The warm-bath, or any other measure by which the circulation may be sustained, *respiration being deficient*, is, I repeat, absolutely destructive. It cannot be repeated too often, that an animal dies of apnœa the more promptly, the warmer the temperature, the more active the circulation in a word, from whatever cause.

Our object in treating the drowned patient must be two-fold : to restore the respiration, but to restore it in a degree proportionate to the degree of the circulation ; and to promote the circulation, in its turn, by any means in our power, again augmenting the respiratory movements as we may succeed in this second object.

These are precisely the two objects which I mentioned in the first part of this volume. It is since that publication that I have ascertained the importance of sustaining a just and due *proportion* between the two

functions, the circulation and the respiration, which it must be our constant aim to promote simultaneously and proportionately—either of these, without the other, being actually fatal. Physiology must be our guide. Empiricism has proved fruitless—nay, worse than fruitless; it has not even taught us, that to raise the temperature, without inducing effectual and proportionate respiration, is, as I have stated, destructive.

With the postural respiration formerly described must be combined the system of energetic frictions of the limbs upwards, with firm pressure, by means of which not only is the venous circulation *best* promoted, but the warmth itself is *best* restored.

These things, too, are accomplished by the bystanders, on the spot, without loss of time, therefore, without apparatus of any kind, and even without medical aid.

Pocket-handkerchiefs should be used as towels, whilst each looker-on may supply some garment—the waistcoat, for instance—to lay under and over the patient, the face, neck, and thorax being, however, if the weather be not inclement, freely exposed to the breeze.

Nothing can be more admirable than the efficiency of postural respiration. Requiring no apparatus, it has solved the difficulty which formerly hung over our efforts to save the half-drowned patient.

It has already saved many lives; and it is destined to save many, many more!

§ III.—*The Apnœa of Still-born Infants.*

The newly born infant and the newly born of many of the mammalia are in a peculiar condition, both in an anatomical and physiological point of view.

The foramen ovale and the ductus arteriosus being still open*, the blood of the pulmonary circulation is still diverted from the channels it is destined to pursue, and in this respect it resembles the reptile tribes.

Respiration, and every stimulus, *except temperature*, being absent, the excitability of the spinal system and the irritability of the muscular system exist in the highest condition, according to a law of animal life which I announced some years ago—viz. that these faculties are, throughout the animal kingdom, *inversely as the stimuli*.

The new-born foetus is therefore a creature of high excitability and irritability. But such an animal bears the absence of stimuli precisely in the same ratio. Respiration is the chief of these stimuli; therefore—to arrive at the subject of this section—the new-born foetus can long survive the absence of respiration.

The condition of apnœa and asphyxia, without the

* This patent condition of the foramen ovale and ductus arteriosus continues, according to the researches of M. Flourens, during eighteen months of extra-uterine life in the human species.—*Histoire de la Découverte de la Circulation*, pp. 67, 69.

absolute loss of life, is therefore of long duration, and the hope of restoring the still-born infant is long protracted; so must therefore our efforts at resuscitation be.

I must here briefly advert to the well-known question of Harvey†, and the not less famous experiment of Buffon, leaving them to my reader's meditation. Harvey asks why the infant which has never breathed bears the suspension of respiration longer than the infant which has once respired? ‡ Buffon had the idea that if the fœtus of the class Mammalia was born under water, and respiration prevented, the foramen ovale and ductus arteriosus would be prevented from closing, and that in this manner life might be protracted under water. A chimera! For what respiration would there be, if both placental and aërial respiration were excluded? But life does not exist without respiration.

Our efforts to restore the still-born infant consist—

- 1st. In measures to induce efficient respiration; and
- 2ndly. In measures to maintain the circulation.

In order that respiration may be effected, we must adopt the following means:

† *Exercitatio Anatomica Secunda de Circulatione Sanguinis Guilielmi Harveii*, p. 258. 1751.

‡ “*Cur fœtus in utero non respirans aerem*, usque ad mensem decimum, ob defectum respirationis non suffocatur? Cur natus in septimo, vel octavo, quam primum aerem inspiraverit, inhibita postmodum respiratione, ob defectum aeris suffocatur?*”

* Did the great Harvey overlook the placental respiration?

1st. The infant must be placed in the *prone* position, in order that all fluids, which might obstruct the entrance into the windpipe, may flow away.

2ndly. Nature's mode of operation being to impress the trifacial and cutaneous nerves, the external *excitors* of respiration, by the external cold, we must dash a few drops of cold water on the face and the general surface.

3rdly. We must proceed, having failed to *excite* respiration, to *imitate* the respiratory movements.

This must not be done by *any forcing* means ; even the human breath, forced into the infant's lips, may *tear* the delicate tissue of the fœtal lungs. We must, on the contrary, adopt some measure of *drawing* the air into the lungs. This is effectually accomplished by first placing the little patient briskly in the prone position, to clear the fauces ; then pressing gently on the back ; and then removing that pressure, and turning it gently on the side and a little beyond ; and so on, perseveringly.

4thly. Meantime, the limbs are to be rubbed, with gentle pressure, upwards, to promote the circulation, by propelling the venous blood towards the heart.

5thly. At proper intervals, we must again endeavour to *excite* the respiration physiologically :

The infant is to be placed with the face prone, and douched alternately and rapidly with water of the temperature of 60° and 100° Fahr.

High and low temperatures are equally excitants of the reflex function of respiration, and their power, within physiological limits, is in proportion to the difference of those temperatures.

We must remember that the newly born infant is a creature of high irritability and low stimulus, and that the foramen ovale and ductus arteriosus are open—both events greatly calculated to protract life and hope in the case of apnœa ; and we must long, very long, *persevere* in our efforts to save the still-born.

The still-born infant has been restored after it has been neglected for hours !

There is a remaining consideration. The effect of apnœa is a condition of the blood surcharged with, and poisoned by, carbonic acid : from this condition of the blood, a secondary asphyxia and convulsions are apt to occur in the adult.

The *remedy* and preventive of such secondary asphyxia would be, free exposure to the breeze, with the inhalation of very dilute pure ammonia.

The treatment of the still-born infant may finally be thus briefly resumed in the form of RULES :

1st. Place the fœtus on the face ;

2ndly. Sprinkle the general surface briskly with *cold* water ;

3rdly. Make gentle pressure on the back : remove it, and turn the infant on the side ; and again place it prone, with pressure ;

4thly. Rub the limbs, with gentle pressure, *upwards* ;

5thly. Repeat the sprinkling, only now with cold and hot water (of the temperatures of 60° and 100° Fahr.) alternately ; or,

6thly. Plunge the infant into a hot and cold bath alternately at 60° and 100° Fahr. ;

7thly. Continue these measures, or renew them, from time to time, even for hours. The embers of life may not be entirely extinct—

“ LATEAT SCINTILLULA FORSAN.”

§ IV.—On *Prone and Postural Respiration*.

The *first* important discovery made in the course of this inquiry—and it is *vital*ly important—is, that there is no *certain* effectual artificial inspiration *in the supine position* of the patient.

It may have appeared to succeed, and yet fail: for on making pressure, a slight *gurgling* expiration is frequently heard, without any subsequent *inspiration*, the real vital process.

It is important to remember that whatever the mode of artificial respiration adopted, in this position—whether the direct application of the mouth, the syringe, the bellows, pressure, &c.—it *may* and *does* fail; nay, that it frequently does worse—driving fluids present in the fauces *fatally* into the windpipe.

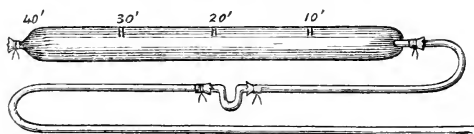
The *second* is—that the very means which had failed whilst the patient was retained in the supine position, became perfectly available when the body was placed in the PRONE position.

The *rationale* of this difference became evident when the position of the tongue and condition of the fauces in regard to fluids came to be *observed* and *considered*.

The *third* discovery—and this is also a vital one—is that, in the *prone* position, *rotation* to the side, and a little beyond, and *repronation*, are attended by *inspiration* and *expiration*.

Lastly, it was found that gentle *pressure* along the spine on pronation, and the *removal* of that pressure before rotation, induced augmented *expiration* and *inspiration*; so that, by combining these two manœuvres, *beautiful life-giving Respiration* is induced.

These results were clearly enough shown in my pamphlet presented to the Royal Humane Society. They have been made still more manifest, and indeed actually measured, by a little apparatus which I have devised for the purpose, and which I have designated the *Pncœometer*. This apparatus is represented in this neat sketch, for which I am indebted to Mr. Charles Hunter :



It consists of a long tube of caoutchouc, fitted to another of larger diameter, made of oiled-silk. The former being placed in one nostril, and the other nostril and the mouth being duly secured by adhesive plasters, the process of rotation and pronation, with alternate pressure, is commenced.

A little fluid being placed in the siphon, the commencement and direction of the respiration is seen by the movement of this fluid; but shortly it is not only seen, but accurately measured by the graduated oiled-silk

bag, which becomes *more* or *less* distended as air passes *into* or *out* of it.

In the midst of these operations, it occasionally happens that a little fluid passes into the tube, with interruption to the free *inspiration* or *expiration*. This is at once made manifest by the condition of the *siphon*.

The *Pncometer* not only detects and measures the degree of the *Postural Respiration*, but demonstrates the comparative worthlessness of *supine*- and the extreme value of *prone*- respiration. The very obstructions to respiration in the former position, find their effectual and appropriate remedy in the latter.

The experiments, which were very numerous, were made at St. George's Hospital, by Mr. Edward Long Fox, Mr. Charles Hunter, Mr. R. L. Bowles, and other gentlemen ; the first being made by Mr. Fox.

The results were always the same : dubious or null in the *supine* position ; admirable and *never failing* in the PRONE position.

When they were concluded, I proposed to Mr. Hunter and Mr. Bowles to repeat them ; and I subjoin the report drawn up by Mr. Bowles :

“ Dear Dr. Marshall Hall,—The enclosed experiments, to each of which I have appended a few remarks, were made by Mr. Hunter and myself, the object being to confirm or correct those previously made for you by Mr. Fox and ourselves, feeling that, from our former experience, we could now guard against several fallacies likely to arise during the experiments. The mode of procedure was the following :

“ An India-rubber tube was inserted into one nostril, the opposite one, with the mouth, being closed, and rendered air-tight by plasters, bandages, &c.; the free end of the tube was now attached to a glass siphon, containing a small quantity of water in its bend, and to the opposite end of this siphon was fastened an oiled-silk bag, made in the form of an intestine, to which it was similar in appearance and calibre, when inflated. This bag, when full, contained forty cubic inches. The water in the siphon acted as an index of the direction of the air in its passage to or from the bag, or, as we have called it in the experiments, the oiled-silk tube; it was the amount of air expired into this tube on pronation, &c. which enabled us to compare it with the natural expiration of thirty inches; for when the tube was half filled, which was easily proved by pressing the air towards its closed extremity, we inferred that we had twenty cubic inches in the tube, and so on. We did not pretend to perfect accuracy as to the amount, but it must be an exceedingly near approximation to the truth.

“ I think you will also see, in these experiments, proof that, though the supine position does not in every case prevent the passage of air, it does so in a *large proportion* of cases; and if it do so in *one* case only, that appears to me quite reason enough why that position should be avoided.

“ Believe me faithfully yours,

“ R. LEAMON BOWLES.”

“ Eaton Place South, Eaton Square, 1856.”

“ SUBJECT I.

“ A male subject, much emaciated, about fifty years of age, and six feet in height; the body was not quite cold, and cadaveric rigidity had but partially come on; he had been dead ten hours. The apex of the tongue reached the incisors, and the body of the tongue was at the floor of the mouth, so that a considerable space existed between its surface and the roof of the mouth. Some fluid was seen at the back of the fauces, and, on laying the body on its face, a large quantity of fluids and solids from the stomach made their escape.

“ *Exp. 1.*—Semi-rotation, prone and lateral. In the former position, the tube was half filled; and in the latter, it was instantly emptied.

“ *Exp. 2.*—By alternate pressure and relaxation on the thorax (the subject *supine*), the same result was obtained as in *Exp. 1.*

“ *Exp. 3.*—Semi-rotation, prone and lateral, was again had recourse to, and with the same result as before.

“ *Exp. 4.*—Alternate pressure and relaxation on the thorax in the *supine* position. *This time, not the slightest inspiration or expiration could be obtained.*

“ On removing the coverings of the mouth, the tongue was seen to be in the same position as when we commenced; but *there was again fluid in the pharynx.*

“ *Remarks.*—This case demonstrates how, in the *supine* position, fluids in the stomach might interfere with respiration; for, in *Exp. 2*, a good result was obtained, no fluid being in the pharynx; but after the fur-

ther movements of Exp. 3, more fluid, &c. had been ejected from the stomach, filling up the pharynx, and totally preventing the passage of air into or out of the trachea. This case also shows that the epiglottis does not in all cases cover the glottis in the supine position.

“ SUBJECT II.

“ A middle-aged man, very much emaciated, having suffered for a long time from abscess of the brain; rigor mortis still present; the brain had been removed.

“ *Exp. 1.*—Alternate pressure and relaxation on the thorax, the body *supine*: *no effect*.

“ *Exp. 2.*—On pronation, about one third of the tube—on applying pressure, nearly the whole tube—was filled; on removing the pressure, the tube was emptied to one third; and on resuming the lateral position, it was quite emptied. These movements were several times repeated, and invariably with the like series of results.

“ *Exp. 3.*—Exp. 1 was repeated. No effect was at first produced; but on pressure being applied by a *sudden jerk*, some obstacle seemed to be removed, and expiration was the result, to such a degree that the tube was nearly filled, as in Exp. 2; and on removing the pressure, the corresponding amount was inspired. After this, alternate pressure and relaxation, in the supine position, produced inspiration and expiration with ease. On removing the tube, no obstacle was to be seen in the pharynx.

“ *Remarks.*—Exp. 1 proves that in the supine posi-

tion *something* does at times prevent respiration in the dead subject ; and although, in Exp. 3, respiration was produced in this position, it could not be done at the commencement ; some obstacle had first to be overcome, probably adhesion of the epiglottis to the back of the pharynx by viscid mucus, as the following observation would tend to prove :

“ On cutting down and removing the right side of the pharynx, with the corresponding halves of the hyoid bone and thyroid cartilage, in another subject, a tolerable view of the position of the parts was obtained. The epiglottis was in direct apposition, by its laryngeal surface, with the posterior wall of the pharynx, so as to preclude the possibility of the passage of air. When, however, the head was allowed to hang backwards over the edge of the table, the bending of the cervical vertebræ caused the posterior wall of the pharynx to recede from the epiglottis, so as to allow the free passage of air. If the tongue had been drawn forwards, would the epiglottis have been removed from the pharynx ? or would the prone position cause it to fall forwards ?

“ SUBJECT III.

“ A middle-aged man, very short and emaciated ; had suffered from extravasation of urine. There was some dulness on percussion on the left side of the chest ; rigor mortis present ; tongue very stiff and moved about with difficulty. Whilst the body was being shifted, we could distinctly hear the rushing in and out of the air.

“ *Exp.* 1.—Free expiration, filling more than half the tube, from pressure in the supine position.

“ *Exp.* 2.—The arms were folded beneath the forehead, and fastened there by bandage. On pronating the body, nearly one third the tube was filled, and on applying pressure, a little more than one third.

“ *Exp.* 3.—As a considerable portion of the chest was, by the arms being folded beneath the head, raised from the table, a block was so placed that, on pronation, the thorax should rest upon it. No better result, however, followed this than in *Exp.* 2, except that by pressure the tube was now nearly half filled. On resuming the lateral position, the tube was emptied as usual.

“ *Exp.* 4.—The head was allowed to hang over the edge of the table, as in all previous experiments : and now the tube was more than half filled, as in *Exp.* 1, on pronation with the addition of a little pressure.

“ *Exp.* 5.—Pressure in the supine position produced the same result as in *Exp.* 1. On removing the tube, the fauces were quite clear, and free from fluid.

“ SUBJECT IV.

“ A middle-aged man ; had suffered some time from a purulent discharge from the side of the chest, with which cavity the opening was supposed to communicate ; and there was considerable dulness on percussion over the same side of the chest. Rigor mortis less marked than usual ; the tongue had dropped back into the pha-

rynix ; but it could not be accurately ascertained whether it quite stopped the way or not ; but

“ *Exp. 1.*—Pressure on the thorax, the body supine, produced *no result whatever*.

“ *Exp. 2.*—Proni-lateral movements, with the head on the table : a little more than one third the tube was filled ; increased by pressure to nearly one half.

“ *Exp. 3.*—Proni-lateral movements, with head hanging over the edge of the table : nearly half the tube full, which took place very readily at first, but afterwards more slowly ; on taking out the tube, *grumous fluid from the stomach was found in it*. After this was emptied out, the experiment was repeated, and the air now passed in and out as easily as at the first, so that the tube was nearly filled.

“ *Exp. 4.*—Pressure on the thorax, the body supine : no result, after repeated trials. It being observed that the abdomen was very lax, so interfering with the amount expired, from allowing the diaphragm to descend, a binder was applied ; but a large quantity of the same fluid as before was ejected from the stomach into the tube. The subject was pronated, and the fluid allowed to run out from the tube and pharynx.

“ *Exp. 5.*—The arms were folded beneath the chest, and the proni-lateral movements employed ; but with very little result ; the effect of the disease of the chest ?

“ *Exp. 6.*—Pressure in *supine* position : no result. On removing the tube, the body of the tongue was far back in the fauces ; but no fluid could be seen.

“ *Remarks.*—It was difficult to say whether it was the tongue or fluid in the pharynx that prevented the passage of air when the subject was supine; but the tongue was much more moveable than in previous cases, and therefore farther back. It was evident, in Exp. 3, that the fluid was the cause of the difficulty.”

These experiments require and merit special study.

On writing to Mr. Fox, and proposing again to repeat our experiments, this gentleman observed—

“ I cannot see that any thing in point of evidence would be gained by repeating the pronation and rotation experiments. They were conclusive to the minds of all of us who witnessed them.

“ On referring to my notes of the experiments at which I assisted, I find that expiration was immediately produced by pronation of the body, except on one or two occasions, in which the tube became filled with the fluid from the stomach, or the trachea was full of grunous fluid after much disease of the lungs. So that I should say, it was *invariably* successful, with the glottis and the mouth free.”

Since this period, the efficiency of rotation and pronation, in inducing respiration, has been confirmed by many observers, amongst whom I may mention Mr. Paget and Dr. Snow.

From all the evidence I draw the following conclusions :

1. In the majority of cases, it was impossible, by

applying and removing pressure to and from the sternum and ribs, to induce effectual *expiration* and *inspiration*, the body being in the *supine* position ;

2. In some cases, the application of the pressure in this position induces a little *gurgling expiration*, *no inspiration* occurring on its removal ;

3. In one case, in which it seemed impossible to induce expiration by making pressure, inspiration became possible after applying pressure with some degree of violence, some obstacle being removed ; was it the tongue which had fallen backwards, and had been replaced by the impulse of the expired air ?

4. In another case, the epiglottis was found, on examination, pressing against the posterior part of the pharynx, so as to obstruct the entrance into the wind-pipe ;

5. In *numerous* cases, fluids, either present in the mouth, or regurgitated from the stomach, were found to obstruct the entrance into the air-passages ;

6. We can therefore never be confident of being able to induce respiration in *any but the prone* position, or position approaching the prone, *by any means !*

7. Nay, one cannot be assured that, in *attempting* to induce *inspiration* in the *supine* position, we do not force foreign matters into the trachea, and so *destroy the patient* ;

8. The same danger attends all other positions, however slightly inclined towards the supine ;

9. In the *prone* position, the means recently pro-

posed to accomplish respiration—viz. *alternate pronation with dorsal pressure, and the removal of that pressure, and rotation*—HAVE NEVER FAILED, although our experiments have been almost innumerable ;

10. It is plain that in the *prone* position the tongue tends to fall forwards, and all fluids flow from the pharynx and mouth, leaving the entrance into the larynx FREE ;

11. It is demonstrated, by our experiments, that when the subject is laid prone, the counter-pressure on the thorax and abdomen induces expiration, the degree of which is augmented by dorsal pressure, and that these phenomena are reversed on removing that pressure and on rotation ;

12. Such manœuvres are *equivalent to Respiration*, and respiration is the remedy for *Apnœa* : the conclusion is obvious.

13. All this can be said of no other mode of proceeding hitherto devised ;

14. In the present state of our knowledge, then, *alternate pronation and rotation, and pressure, as just explained, are the remedy for Apnœa.*

15. But these measures must be administered *on the instant, on the spot, in the free air ;*

16. All *delays*—and *all* other measures hitherto discovered and applied are delays : removal, the warm bath, galvanism—are *homicidal* !—a verdict which no authority, nothing short of such indubitable experiment, made by competent persons, as has *not* yet been made, can gainsay.

17. Continued cold, within physiological limits, prolongs life in the circumstances of apnœa; continued warmth shortens it, and is therefore *opposed* to recovery, notwithstanding the place it has so long held amongst the rules for rescuing the drowned, &c.

18. *Sudden* cold and sudden heat, and especially the two alternately, are, on the contrary, *excitants of respiration*, and therefore remedies in the *early stage of apnœa*.

19. In general, nothing can be of more fatal tendency than the time lost in removal—the warm bath—galvanism;

20. I know of nothing in medicine so near *demonstration* as the proofs of the dangers of the former system, and of the simplicity, the safety, and the efficacy of the *Eupnœa* of postural respiration.

§ V.—*On the Inhalation of dilute pure Ammonia in Apnœa.*

I have great reason to believe that there is much promise of good from the inhalation of dilute pure ammonia in apnœa. I detail two experiments very succinctly:

I placed one mouse in five ounces of atmospheric air: it died in *forty* minutes.

I placed a second mouse in the same quantity of atmospheric air, into which pure ammoniacal gas was diffused: it survived *ninety* minutes!

The difference between these two experiments is that of carbonic-acid blood-poison, retained unchanged, and exhaled or neutralized.

Since these experiments, part of a séries, were made, Dr. J. W. Ogle and Mr. Lloyd Bullock have kindly repeated them, and have arrived at the same conclusions : the addition of dilute pure ammonia prolongs life in an animal confined in a limited portion of atmospheric air. It is therefore an antidote to the carbonic-acid blood-poison in apnœa. Being inhaled, it not only neutralizes the carbonic acid in the air-cells of the lungs, but, being also absorbed, it doubtless neutralizes that other portion of this poison still circulating in the blood, and, through it, in all the organs.

What a beautiful subject for new experiment !

But a special use for the dilute vapour of pure ammonia presents itself in the case in which we have to contend with the vapour of burning charcoal and other forms of carbonic acid.

Those who descend into such a vapour in wells, the coal-pit, the brewing-vat, for whatever purpose, should wear a mask, exhaling the vapour of dilute pure ammonia. Those who have breathed an atmosphere surcharged by carbonic acid, should be succoured by the same agent. The state of the atmosphere too crowded by people, or too much imbued by the results of the combustion of gas, should be corrected by the same means, attention being paid to due ventilation.

The inhalation of dilute pure ammonia is the special preventive of secondary apnœa.

§ VI.—*Of the Inhalation of Oxygen.*

Is oxygen really a remedy in apnœa? Is it as efficacious as atmospheric air? Is oxygen more rapidly absorbed in slow combustion from pure oxygen than from atmospheric air? This too presents a subject, not for hasty conclusions, but for careful experiment.

§ VII.—*The Rationale of the fatal Tendency of the Warm Bath in Apnœa.*

There is a physiological relation between the circulation and the respiration, any deviation from which, in either direction, is of a fatal tendency.

During the systemic (not the pulmonic) circulation, carbonic acid is formed; in respiration, the oxygen necessary for the formation of this carbonic acid is supplied, and the carbonic acid so formed is evolved from the system.

The immediate baneful effects of the suspension of respiration arise from the privation of oxygen, and from the retention of the carbonic acid previously formed, which becomes the blood-poison.

An animal placed in perfectly *pure nitrogen* or *hydrogen* gas dies in violent convulsions instantly. And this is doubtless owing to the privation of oxygen; for

carbonic acid might be exhaled into nitrogen or hydrogen gas.

But an animal dies also in air consisting of such proportion of *carbonic acid with oxygen* as to prevent the evolution of carbonic acid from the blood, although the quantity of oxygen might be so great that a taper blown out, and burning only as a *spark*, would be instantly re-kindled into *flame*.

If, without producing effects so sudden as those described, we change the relative proportion of the respiration and the circulation, morbid phenomena are produced special to each case. If the circulation be disproportionately augmented, carbonic acid is formed, and being morbidly retained, slighter convulsion and slower death ensue. If the respiration is unduly and disproportionately augmented, the animal is *cooled*: for mere *pulmonary* respiration is a cooling process, by the difference of temperature of the *inspired* and *expired* air; and in this case also the animal dies, but now from loss of temperature.

This latter is the case in the patient affected by apnœa, if the respiratory movements be unduly hastened—that is, disproportionately to the rapidity of the remaining circulation.

On the other hand, if, in apnœa, we excite the circulation without simultaneously and proportionately inducing respiratory movements, we destroy our patient by carbonic acid, formed in the course of that circulation, and uneliminated by respiration.

This statement leads me to the proper subject of this paper—the Rationale of the Injurious and Fatal Tendency of the Warm Bath in Asphyxia: for it is injurious, and has, I am profoundly convinced, of itself proved fatal in cases in which the patient, without it, would have *spontaneously* recovered. Such a case indeed did occur recently at Boulogne.

In such a case, it is surely not less essential to the progress of science and our art to remove error than to establish truth.

Warmth is so obviously a stimulus, and a stimulus is so apparently required for a patient taken out of the cold water in a state of apnoea, that in recommending the warm bath we seem to be addressing ourselves to the common sense of mankind, and it was a step in advance to enteratin a *doubt* on the subject.

But when we begin to experiment—when we learn that an animal deprived of respiration by being submerged under water, *lives longer* in *cool* water than in *warm* water, we learn to consider whether, in fact, coolness is not more favourable to life in the apnoea from submersion, than warmth. We recall to mind, too, that animals bear the abstraction of respiration in proportion to their coolness: the hibernant animals and the batrachian tribes will scarcely drown at all. If a kitten be first cooled, or if it be immersed in cool water, it will not drown so soon as it would do if submerged at its ordinary temperature in water of the same temperature—facts established by Edwards, by

M. Brown-Séquard, and myself, and witnessed by the secretary of the Royal Humane Society, and by its superintendent in Hyde-park.

Thus experiment is made to correct preconceived ideas, however apparently consonant with common sense.

There are other facts which point to other modes of treatment of the drowned, which the administration of the warm bath necessarily excludes. If a poor creature be perishing for want of *food*, we cautiously administer *food*. If a man be, in like manner, perishing for want of *air*, should we not administer *air*? Is not this simple and reasonable? And in the case of drowning, is not the want of air the first condition to which we should bring succour, and the want of temperature the second or third? And should we not first administer to the first want? Then, in the case of drowning, we should administer air first, and warmth in the second place. But may not the warmth administered without air, do great and absolute injury? It raises the temperature, and in so doing augments the necessity of respiration to life.

In the *first* place, if *any* effect be produced by the warm-bath, the circulation is accelerated. But to accelerate the circulation without inducing, at the same time, efficient respiration, is to augment the formation of carbonic acid—the *blood-poison*,—without its elimination from the system, and it induces, consequently, a fatal result;

Secondly, all *excited* respiration through the medium of the cutaneous excitor nerves is excluded, the uniform

temperature of the warm bath excluding the excitants of those nerves arising from the *alternate* application of *heat* and *cold* to the surface ;

And *thirdly, imitated* respiration is excluded by the very sustained position of the patient, excluding, as it does, alternate pronation and rotation, and pressure applied and removed—those changes of position and compression which induce respiratory movements.

So that the warm bath is not only positively injurious by *poisoning*, but negatively, by excluding the *de-poisoning* process.

Lastly, the warm bath excludes those frictions of the limbs upwards, with pressure, which really constitute the most effectual means of promoting the circulation and warmth.

Nor is it unimportant to save the *time* expended in preparing the warm bath, or in carrying the patient to it.

And it is scarcely a minor point to direct *all our thoughts and energies*, undiverted, to *the* important remedies exclusively.

In conclusion, the warm bath is of *doubly fatal tendency* : it is so in itself positively ; and it is so negatively, by excluding every real remedy.

All have heard of the *Grotto del Cane*. The poor dog is put into carbonic acid, and taken out affected by apnœa. It is plunged—not into a *warm bath*—but into the shallow water of the adjoining *lago Agnano*, and taken out—restored !

I cannot conclude this section better than by ad-

ducing the penultimate paragraph of Edward's admirable work :

"We have seen," says this profound physiologist, "how fatal heat is in asphyxia (apnœa), or in cases of restricted respiration." "If the application of heat be *continuous*, it will prove fatal. In some cases it may be useful, if it be of *short* duration: when an animal is plunged into water at 104° Fahr. its movements are much more energetic, but less numerous, than at inferior temperatures. There are circumstances in which a *momentary* application of heat may be employed to *excite* movements of the thorax. The immersion of a great part of the body in hot water is frequently an efficacious means for animating the still-born infant. But as soon as such movements are produced, or if they do not occur, we must renounce a mode of proceeding of which the prolonged use would be fatal !"*

§ VIII.—*The Danger of all Attempts at Artificial Respiration, except in the Prone Position.*

I have shown, in the last section, not the inutility only, but the *danger* of the *warm bath* in the treatment of apnœa or asphyxia. I now proceed to demonstrate the danger of all attempts at the induction of artificial

* Des Agens Physiques, p. 529-530.

respiration—the special remedy against apnœa,—except in the PRONE position.

If the patient, in apnœa, be moved and placed in the supine position, in which no attempts at artificial respiration can be effectually made, what is the condition of the rima glottidis or entrance into the windpipe? Is it *free*, so that air may be pressed or drawn into it? And if apparently free, does it remain so at the moment when an effort to force or draw air into it is made?

1. Is the tongue so securely situated, all muscular energy having ceased, as neither to *fall* backwards, nor to be *drawn* backwards, and so close or obstruct the orifice and entrance into the windpipe?

2. Is there no accumulation of mucus, or other animal fluids, or of fluids from regurgitation from the stomach, which may also obstruct the glottis? nay, more, which may be forced or drawn into the windpipe, inducing a *second* and fatal suffocation?

No one can say, *à priori*, that one, or even both, of these events may not occur. These are not only possible, but probable,—not *only* probable, but inevitable under certain circumstances.

There is one fact of the utmost importance. When, from any circumstances, the nervous and muscular powers are in abeyance, nothing is so common as regurgitation from the stomach, from change of position, compression, &c. Under such circumstances, compression of the *sides* of the thorax would certainly be apt to produce this effect. Now, in the supine position, the matters so

regurgitated would remain in the fauces, obstruct the glottis, or, when the pressure was removed, be drawn into the windpipe! Leroy's mode of attempting to effect artificial respiration, of which a sketch is given by the Royal Humane Society in its Reports, is utterly ineffectual; but if effectual, would be replete with danger. The only certain safeguard against such a fatal accident is—the *PRONE position*. In this position, the tongue tends to fall forwards, and all fluids flow from the fauces and the mouth, or are expelled by the first induced expiration.

All this is reasonable, *à priori*. But we must not rest here. Our appeal must be to *facts*, not to mere notions. The facts must be ascertained by careful examination of the dead subject.

1. What *is* the position of the *tongue* when the body has been roughly moved about and laid in the supine position, all cadaveric rigidity of the parts being overcome by previous movement of this organ backwards and forwards?

2. What is the further position of the tongue in the supine position, at the moment of attempted inspiration, first, by means of the bellows, or, secondly, by the removal of the pressure on the ribs or sternum, and the consequent dilatation of the thorax?

These facts may be ascertained by removing the tissues on one side of the neck, so as to give a lateral view of the tongue, glottis, epiglottis, and pharynx, and by replacing those tissues by a portion of transparent glass of the proper size and form, properly placed and carefully maintained in its position.

The first part of this examination has been already made:—The subject being placed in the supine position, and the lateral parts of the neck being removed, so as to admit of observing the relative position of the internal organs—the tongue, the epiglottis, the glottis, the pharynx,—it was seen that obstruction to the entrance of air actually *did* take place.

I now propose to place a piece of transparent glass so as accurately to close the cavity and allow of the observation, first, of the effect of *position*, the supine and the prone comparatively, and then of any attempt to induce *inspiration*.

A similar examination of this internal cavity in reference to fluids present in it—and we never can know when such fluids are present—is unnecessary: fluids will, in the supine position, gravitate to the lowest parts of a cavity, and will be drawn into an open orifice, such as the glottis, under the influence of air forced or inhaled into it. And such an event not only renders all attempts at *inspiration* nugatory, but induces a permanent, because material, obstruction of the entrance in the windpipe.

In confirmation of these views, I revert to experimental *facts* already given.

“The following experiment has been repeated *many times*, and has been witnessed by George Webster, jun. Esq. of Peckham, Mr. Williams, superintendent of the Royal Humane Society, Hyde-park; and other gentlemen:

The dead subject being placed in the *supine* position, and pressure made on the sternum and ribs, a little

gurgling was heard in the throat; but, the pressure being removed, there was *no* evidence of *inspiration*."

Now let us contrast with these abortive attempts to induce artificial *inspiration* in the *supine* position, the beautiful and life-giving results—*inspiration* and *expiration*—of alternate rotation from the PRONE position and repronation. I continue the quotation :

"The subject being then turned into the PRONE position, and pressure being made on the spine and the ribs, and removed as before, there were free *expiration* and *inspiration*."

Far more marked is the effect of pronation and rotation :

"The subject was turned into the prone position: considerable expiration took place, which was much augmented by pressure of the hands on the back. On removing this pressure, a little inspiration took place. The body being then rotated on the right side, considerable inspiration again took place, whilst moving through one fourth of a circle; on continuing the rotation, inspiration continued until the shoulder was half-way between the lateral position and the table, when it ceased."

I conclude the momentous subject by several *aphorisms* in regard to the treatment of apnœa:—

1. The effects of suspended respiration can only be removed by the renewal of respiration.

2. Artificial respiration can only be certainly, effectually, and safely performed in the PRONE position;

3. In the *supine* position the larynx is apt to be obstructed by the falling back of the tongue and epiglottis, or by the accumulation of fluids already in the pharynx or regurgitated from the stomach.

4. These fluids may be *fatally* inhaled into the windpipe when *inspiration* is mechanically effected.

5. All other measures are subsidiary, even the rubbing the limbs with pressure upwards; and all which exclude respiration are, *ipso facto*, destructive; the *warm bath* is of *doubly fatal* tendency,—first, by excluding pronation and rotation, and secondly, by promoting the formation and the circulation of the blood-poison—carbonic acid.

§ IX.—*On the Prognosis in Apnœa.*

The prognosis in apnœa (or asphyxia) depends upon three elements:

First, the physiological *constitution* of the patient;

Secondly, the *stage* of the apnœa (or asphyxia);

Thirdly, the *promptitude* with which the chief remedies, respiration, or pronation and rotation, are administered.

The physiological constitution of the new-born infant is that of low stimulus and of high irritability. The respiration is, in fact, the respiration, so to speak, of the fish tribes—the placenta representing the branchiæ; and

even of the lowest of these, the extent of surface of the placenta, compared with the magnitude of the animal, being considered.

But the duration of life in apnœa is in the inverse proportion of the quantity of respiration; that is, the less the degree of respiration, the longer its suppression can be sustained without the extinction of life. The *same* hibernant animal lives a longer or a shorter time submerged under water, just according to the degree of hibernation, with its low respiration, in which it may be placed, and dies more promptly as that hibernation is exchanged for activity with *its* high respiration.

The degree of respiration is always linked with proportionate circulation—as effect is linked with its cause—or as supply is linked with demand. The quicker the circulation, the quicker the formation and elimination of carbonic acid, or the *blood-poison*, but the ordinary *excitant* of respiration, the degree of *necessity* for its elimination, being in the same proportion. Hence the destructive tendency of the *warm bath*, in the ordinary sense of this phrase; for I do not now speak of the *sudden and momentary hot bath* (which may prove an excitant of respiration), but of the ordinary *continued* warm bath, which, if it accomplish any thing, augments the circulation, respiration being still in abeyance; with this augmented circulation, there is augmented formation of the blood-poison, carbonic acid; and this being *retained*, proves a “choke-damp,” and, in a word, destroys life. Now the warm-bath at the Royal Society’s receiving-

house has been a *warm* bath, and has usually been *continued* during twenty minutes.

But to return to the *practical* object of this section, which will be found, as ever, to coincide with *theory*—(so commonly and ignorantly decried),—the new-born infant is a creature of the *lowest* degree of respiration. Its life, and the hope of its restoration in apnœa, is—the *longest*. I believe that, in almost every case of the apnœa of the still-born, the success of the postural respiration will be complete. For the same reason, the application of this method should be *the most persevering*.

In regard to the *stages* of apnœa (or asphyxia), I may observe that there are most distinctly *four* :

The *first* is that in which the breathing is not quite extinct ;

The *second*, that in which the respiration has ceased, but may be *excited* by those means which I have so distinctly pointed out on various occasions ;

The *third*, that in which respiration has not only ceased, but is *in-excitable*, and in which therefore our *hope* of resuscitation is in *imitating* or *inducing* the respiratory movements—that is, in *pronation* and *semi-rotation* ;

The *fourth* and last stage is that of true *asphyxia*—that in which not only all respiration, but all *pulsation* has ceased, and with it *almost* all hope. Sir B. C. Brodie says, emphatically—“ *If that action of the heart by which the circulation is maintained should cease, it can never be restored. This I positively assert, after*

*having made it the subject of a very careful investigation.”**

In the cases of the drowned or the strangled, the patient may come under our notice in any one of these stages, or in any prior, posterior, or intermediate condition.

The course of *this* apnœa or asphyxia is extremely short: *four* or *five* minutes of complete submersion is supposed to be hopelessly fatal. In a given case, the hope is precisely commensurate with the *promptitude* with which this treatment is applied. Certainly the plan or rules recently proposed to the Royal Humane Society to be adopted *before* postural respiration—that is, *the time lost*—would extinguish all chance, all hope, and therefore *all fair and honest trial of that method*; and I trust that Society will, for its own honour and credit, reject all such insidious proposals.

The *moment* we see the drowned patient, we should *observe*, for a moment, whether there be respiration, and if so, *wait* and still *observe* carefully; if breathing continue, be careful of interfering; and, constantly watching, direct the wet garments to be removed, and the limbs to be rubbed, dried and clothed as promptly as possible, every one contributing some article of clothing.

But if the breathing has ceased, if there be real apnœa, then, without any delay of any kind, we should enforce *at once the best measures*; and those are already

* Lectures on Pathology and Surgery; 1846; p. 81.

demonstrated to be those already described, *unpostponed*.

I regard the new Rules lately proposed to the Humane Society as unfair towards the new method, and as fatal to the patient. I believe it to be absolutely *impossible* that any asphyxiated patient should *so survive* the *preliminary* measures proposed in those Rules, as to be subsequently recovered, or *recoverable*, by that method, or *any* method.

The prognosis in cases of drowning, &c. is made up then of three elements: 1. the *constitution* of the patient; 2. the *stage* of the affection; 3. the *promptitude* of the treatment; to which, of course, must be added the *adequacy* of the remedies.

In concluding, I wish briefly, but distinctly, to restate the chief practical points embraced in those remedies:

1. It is obvious to all unsophisticated persons that the effects of

Suspended Respiration,

by whatever cause, are only to be removed by the

Restoration of Respiration.

2. It is proved by experiment on the dead subject that respiration is effected by the

Pronation, and

Rotation of the body, with pressure duly applied and removed.

3. The special remedy for apnœa, then, is this

Postural Respiration.

§ X.—*On Narcotic Poisoning.*

Many years ago, a lady drove to my door (in Manchester Square) from Avenue Road, in the utmost consternation, having shortly before swallowed an ounce and a half of Battley's solution of opium, in mistake for a senna draught.

I instantly applied the stomach pump with my own hands, and her life was saved !

I have often asked myself the question—What should I have done, had I not had the stomach pump in all readiness, and had I not been able to induce vomiting ? Until this hour, I knew not how satisfactorily to answer this fearful question.

There are two stages in narcotic poisoning, in each of which postural movements are, in the absence of the stomach pump, our *hope*.

The *first* is that in which our object is to remove the poison from the stomach by the induction of mechanical *vomiting*, but in which, from the degree of narcotism, all physiological remedies fail.

The *second*, that in which our object and hope are, to continue respiration *until* the elimination of the poison from the system may be accomplished.

In the former case, the patient should be laid on a table, with the head projecting beyond its edge, if possible ; and, being placed on the *side*, the finger of one person is to be introduced into the *fauces*, whilst the

body is briskly and repeatedly rolled into the *prone* position, and pressure or a smart blow on the back applied by another.

If there be the slightest degree (“*scintillula*”) of excito-motor power remaining, the *cardia*, already somewhat relaxed from torpor, will be still further relaxed, physiologically, whilst the *glottis*, the safety valve of the trachea, is closed, and the *thorax* and *abdomen* being compressed by a force equal to the superincumbent weight of the body, to which further force may be added by means of pressure made along the spine, *mechanical* vomiting will be produced, and the poison expelled.

This desirable effect will be produced in cases in which the narcotic torpor is too great to admit of exciting the very complex act of *physiological* vomiting.

But now let us suppose that the narcotism is too deep for the success of this manœuvre,—that the *second* case is before us. Then our hope consists in continuing respiratory movements until the poison is eliminated from the blood and the general system. In one word, our hope is in prone and postural respiration, such as I have recommended it for apnœa.

I suppose that volition has ceased, and that the patient can no longer be made to move or walk about; that all good physiological respiration has ceased, or is about to cease; then—then one hope still remains—postural respiration—and the other measures comprised in the treatment of apnœa; and I need not say how long and perseveringly this method should be continued.

§ XI.—*The Laryngismus of Chronic Laryngitis.*

Chronic laryngitis is liable to extreme and dangerous spasmodic exacerbations, assuming the form of laryngismus.

In a very early volume of the Medico-Chirurgical Transactions, I published a case of Chronic Laryngitis in which *tracheotomy* was instituted to protect the patient from the immediate danger from these paroxysms of laryngismus, whilst *mercury* was freely administered as the cure of the laryngitis.

Such is always the place occupied by tracheotomy. It is itself a *cure* for no disease.

It is in such a paroxysm as I have described that postural respiration might save the patient, if most timely applied. And unless tracheotomy be instituted, due warning of the imminent danger of these paroxysms, and of the remedy, should be given to the friends of the patient.

I see this subject recently noticed by Dr. Eben. Watson, in his very able and valuable work on the "Local Medication of the Larynx" (p. 82).

§ XI.—*The Laryngismus of Convulsion and of Epilepsy.*

There are *two* cases of sudden death in convulsion and epilepsy: one of these is *syncope*; the other, *laryngismus*.

These events are not uncommon even, in that convulsive affection designated laryngismus stridulus; and I have met with an instance of the same kind in a little girl, aged ten, afflicted with epilepsy; and another in a youth, a medical student.

The fit of *pertussis*, so apt to pass into convulsion, may also terminate in fatal apnœa, laryngismus being the intermediate connecting link in both cases, and timeous postural respiration the remedy in the latter.

In the laryngismus of these cases, the spasm, with its apnœa, may continue so long that, when it has ceased, the pneumogastric may no longer be *excitable* by the contact of the carbonic acid in the lungs, and the apnœa may issue in fatal asphyxia. It is *at such a moment* that postural respiration would probably rescue the patient from his danger.

The caution and proper instructions should be given to every one having charge of the infant affected by laryngismus stridulus, and to every parent having an epileptic son or daughter. Fortunately the remedy is at hand, and most easy of application.

I may take this occasion to place on record the surmise that, in many cases of epileptic laryngea, the blood remains over-charged with carbonic acid; this may be the source of the dark *epileptic complexion*; the remedy is the inhalation of dilute pure ammonia.

§ XIII.—*The Laryngismus of Strychnine.*

Judging from many experiments, I believe that strychnine destroys life in *three* ways :

1. By inducing *laryngismus* and apnœa ;
2. By inducing exhaustion of the nervous power, the effect of spasm and pain ; and
3. By a secondary asphyxia.

The *first* object in the treatment is, of course, to get rid of the poison. Emetics must be given. But if these fail, the hopeful remedy is, to place the patient *prone*, and, in the interval between the spasms, to tickle the fauces with a feather or other object.

The *second*—the important remedy, is—*tracheotomy*. In my experiments, I gave the same poisonous dose of the acetate of strychnine to *each of two* dogs, and performed tracheotomy in *one* ; and left them undisturbed for the night. The one in which tracheotomy was performed *lived* ; the other infallibly *died* ! Tracheotomy disarms laryngismus of danger—of its apnœa.

The *third* remedy is the postural method, with two objects : the first, to administer respiration as the remedy for the *effect* of the laryngismus, &c., and its apnœa or suspension of respiration ; the second, adding tickling to the fauces, again, to empty the stomach ; a third may be, even when all spasm has ceased, to *continue* the alternate pronation and rotation, that is—respiration,—in the hope that life may be continued until the poison may be eliminated from the system, as well as mechanically regurgitated from the stomach.

§ XIV.—*The Laryngismus of Choking.*

Death in choking is the result of a diastaltic^e or reflex spasmodic closure of the glottis.

Nothing can be done in this stage of the accident, except,

1. To endeavour, by introducing the finger into the fauces, to induce vomiting ;

2. To introduce something *like a bougie* into the œsophagus (a firm scroll of linen being the readiest); or,

3. To adopt a measure which I adopted on an emergency, with immediate success, some years ago :

A little boy, eating some fowl in haste, attempted to swallow too large a morsel, and was choked ; I ran to him, placed him between my knees, one knee (the right) pressing firmly on the stomach, the other on the back ; I then placed one hand (the left) on the back part of the thorax, whilst I gave a firm blow with the other on the sternum. In an instant I had the joy of seeing the morsel of chicken expelled with force to a considerable distance ; and all was safe !

But supposing all these efforts to fail. What is then to be done ?

In the midst of the apnœa induced by the closure of the glottis, the excito-motor power at length fails, and the larynx is no longer spasmodically closed ; and now postural respiration may be adopted, with the effect of sustaining respiration and life, until such a bougie is

made as shall be effectual in pushing down the morsel of food or other object in the pharynx or œsophagus.

A *firm* scroll of cotton or linen, when imbued with grease, made from a sheet, a window-blind, or curtain, may be made, not in too great haste, and be boldly passed into the œsophagus.

The morsel of food is generally lodged in the pharynx, or *upper* part of the œsophagus, and, when forced lower down ceases to excite reflex action of the larynx; and breathing is, therefore, possible.

A thin bent tallow-candle, or a piece of firmish *cord* (taken from the window-frame), might answer the purpose of the bougie.

Postural respiration procures us the *time* necessary for obtaining *any* of these means, and for giving full directions to the assistants. In performing it, a little brisk movement and even a smart blow may be adopted too in pronation, and in making dorsal pressure, which may, if not at first, eventually, dislodge the foreign body.

I need scarcely suggest that this last measure should also be enforced in cases of a foreign body inhaled into the larynx both *before* and *after* tracheotomy, with the addition of a firm blow with the open hand, on the back.

§ XV.—*On the Time the Patient may be submerged.*

Many exaggerated accounts are on record in regard to the length of time during which a patient may be submerged, and yet recover.

The general principle has already been stated: the higher the temperature, the more rapid the circulation, the quicker the respiration, — and the greater the necessity for air; the sooner, therefore, the apnœa will become fatal asphyxia.

If a person be running, and fall into the water, that fatal asphyxia will soon take place.

Skaters, warm with skating, speedily perish, though life will be prolonged by the *coldness* to which they are exposed.

Those who are without active exercise on the ice, and therefore cold, will live longer if submerged in the water.

But the duration of apnœa is longest in those who, from any cause, experience a considerable reduction of the pulse and of the temperature, of course within physiological limits: a degree of *syncope* occurring as the person is submerged—from fright, for example—will enable him to sustain the privation of air longer than those whose circulation is vigorous. If a degree of *shock* be sustained from the fall or plunge into the water, the same effect may be produced.

It is in such circumstances that the long period of

immersion said to have been sustained, must, if true, be explained.

Sometimes the immersion is not constant or complete ; as, when the patient rises to the surface, or the water is shallow ; and then life will, of course, be protracted.

In general, apnœa is more speedily fatal in summer than in winter, in the young and robust than in the feeble, in the active than in the inert. I think it must be admitted that very young children live longer, when deprived of air, than adults.

These facts are confirmed by physiological considerations, to be briefly detailed in Part the Third of this little work. All, indeed, is physiology.

Two things are obvious, and of great practical value : the first, that whilst we should not *lose a moment* in adopting the postural respiration, we should not be deterred from *persevering* by the apparent hopelessness of the case, or the too ready desponding observations of the bye-standers. We know not what event may have occurred to reduce the circulation and the consequent necessity for respiration.

All physiology, all experiment, the whole of the works of Edwards and of M. Brown-Séquard, my own investigations, all support these views, of which the hibernant animal and the batrachian, present the most marked illustrations. The *differences* amongst our patients may be small ; but they are not the less real.

These considerations lead, especially, to *perseverance*, in our breath-giving, life-giving, postural manœuvres—

and the embers of life *may* be smouldering when we *think* them extinct.

§ XVI.—*Formulae for Prone and Postural Respiration.*

I conclude Part Second by adducing the latest *Rules* for the treatment of apnœa, in their most simple but distinct forms, and suited to general, not to say universal, application.

They have *never failed* to produce good respiration, in cases in which the pharynx and larynx have been free from matters regurgitated from the stomach or expelled from the lungs; and these failures only apply to our experiments with the Pnœometer, not to our efforts to save the patient; for, in the prone position, even such events find their instant remedy.

I believe I may assert that this mode of artificial respiration will succeed in every case of *apnœa*; it will fail, I fear, whenever that *apnœa* has, by delay or otherwise, passed into *asphyxia*.

The first object is to clear the *Throat*;

The second, to *Excite* respiration physiologically;

The third, to *Imitate* respiration; and I have a remark to make—not, I think, made before: it will be observed that the process of imitated respiration *begins*, not with *inspiration*, but with *expiration*, this being the effect of the *prone* position with dorsal pressure.

In the first place, it is obvious that in this manner

we *second* the rule for *clearing the throat*, the effect of mere position, by adding one which may *clear the trachea* by inducing expiration; it may be *brisk* respiration; and if, instead of pressure on the back, we apply a smart *blow*, it may do more still.

In this, I believe, we imitate Nature too: the compression of the infant's thorax and abdomen as it passes, after the birth of the head, through the vagina, must act in the same manner, *first* producing *forcible expiration*, and so expelling all mucus from the air passages.

A similar event, issuing in good, has been seen to result from effecting *expiration* by a strong effort of *suction* by the mouth applied to the mouth and nostrils.

The late Mr. Reid invented a double-acting syringe, the objects of which were, *first*, to induce *expiration* and then *inspiration*. I do not know whether it was ever used. It may, I believe, still be seen in Regent Circus, Piccadilly.

Prone and postural respiration happily takes the place of *all* such manœuvres and instruments.

These measures are portrayed in the most simple manner in the following table:

RULES

FOR PRONE AND POSTURAL RESPIRATION.

I. *Rules to be applied in every Case.*

1. Treat the patient *instantly, on the spot, in the open air, exposing the face and chest to the breeze* (except in severe weather).

I.—To Clear the Throat—

2. Place the patient gently on the face, with one *wrist* under the forehead ;

[*all fluids and the tongue itself then fall forwards, leaving the entrance into the wind-pipe FREE.*]

If there be breathing—wait and *watch* ; if not, or if it *fail*,—

II.—To Excite Respiration—

3. Turn the patient well and *instantly* on his side, and—

4. Excite the nostrils with snuff, the throat with a feather, &c. and dash cold water on the face previously rubbed warm.

If there be no success, *lose not a moment, but instantly—*

III.—*To Imitate Respiration—*

5. Replace the patient on his face, *raising* and supporting the chest and abdomen *well* on a folded coat or other article of dress ;

6. Turn the body very *gently on the side and a little beyond*, and then *briskly* on the face, alternately ; repeating these measures deliberately, efficiently, and perseveringly *fifteen* times in the minute, occasionally *varying the side* ;

[*when the patient reposes on the chest, this cavity is compressed by the weight of the trunk, and expiration takes place ; when he is turned on the side, this pressure is removed, and inspiration occurs*].

7. When the *prone* position is resumed, *make* equable but efficient *pressure*, with brisk movement, *along the back of the chest ; removing it gently immediately before rotation on the side ;*

[*the first measure augments the expiration, the second commences inspiration.*]

* * * THE RESULT IS—RESPIRATION ;—AND, IF NOT TOO LATE,—LIFE

IV.—*To induce Circulation and Warmth—*

8. Rub the limbs *upwards*, with *firm grasping pressure* and with *energy*, using handkerchiefs ; &c.

[*by this measure the blood is propelled along the veins towards the heart*].

9. Let the limbs be thus dried and warmed, and then clothed, the bystanders supplying coats ; &c.

10. *Avoid the continuous warm-bath, and the position on or inclined to the back.*

II. *Rules for the Treatment of the Still-born.*

I. The first object is to *clear* the *Throat* and nostrils of mucus.

1. This is best done by the prone position, pressure along the back, &c.

2. By seizing it, as it appears, by a piece of soft linen.

II. The second object is, to imitate Nature, and *Excite* respiration ;

1. The alternate hot and cold douche, or

2. The alternate hot and cold bath, or

3. Excitants applied to the nostrils or the skin, are the most effectual measures.

III. The third, the all-important measure, is, to *Imitate* respiration by

Alternate rotation, and pronation with pressure ;

IV. Next follow friction along the limbs upwards, with flannel ;

V. The continuous *warm* bath, as distinguished from the sudden alternate *hot* and *cold* baths, is to be carefully avoided, as causing loss of time and the neglect of all-important remedies.

VI. Very dilute vapour of pure ammonia should be inhaled into the *lungs*.

CASES.

Recently a melancholy event occurred at Scarborough :

A gentleman, bathing in the sea, was, as is supposed, seized with cramp, and was only rescued from the water as life seemed about to become extinct. The patient, instead of being treated instantly, on the spot, was "conveyed," as formerly directed, to the bathing-house : on the way, he breathed several times ; on his arrival, he seemed irrecoverably dead !

I add another anecdote, not less deplorable :

A young person was bathing at Boulogne-sur-mer, and was rescued when nearly drowned. Breathing was partially restored, when the superintendent of the "Société Humaine et des Naufrages," as related to me by himself, was very reluctantly induced to place the patient in a warm bath. The breathing ceased, and in this bath the patient expired !

CASES.

I. CASES OF DROWNING.

CASE I.—*By Dr. Alexander, of Dundonald, Kilmarnock.*

The first case which occurred, and in which postural respiration was instituted, was that of Dr. Alexander; and it is full of instruction.

Though improving under the influence of this treatment, it was thought proper to try the effect of the warm bath; the child grew worse!

The postural respiration was resumed, and it was restored!

In a letter Dr. Alexander observes: "As I have been the first to put your admirable method into practice, probably I have been the first to notice the injurious effects of the warm bath." "*I believe the child would have died in it, had it not been removed.*"

Dr. Alexander's case of the resuscitation of a still-born infant is also the first saved by the postural method of respiration.

To the Editor of The Lancet.

"Sir,—When Dr. Marshall Hall first published in your columns, on April 12th, 1856, his Ready Method of treating asphyxia, I felt so convinced of the soundness

of the views then promulgated, that I resolved to test them practically on the first occasion which should present itself. I had not to wait very long for an opportunity of doing so.

“On the 31st of May, 1856, I was sent for express to visit a female child, aged two and a half years, said to have been drowned in a tubful of soap-suds. I had a distance of fully two miles to ride, and started with a feeling that my labour would be all in vain. Half an hour must at least have elapsed from the time the child was discovered in the water until I reached the spot. On arriving, I found the child stripped of her clothes, wrapped in a piece of flannel, reclining on her mother’s knee, and people assiduously applying warm flannels to various parts of the body, accompanied with frictions. The child occasionally gave a sort of gasp or sob, with a slight quiver of the body; the eyes were projected and fixed, and the pupils dilated: the pulse could not be felt.

“The postural movements, with upward frictions, as recommended by Dr. Marshall Hall, were immediately commenced, and after forty minutes’ continuance, respiration became more regular, but not so satisfactory as I could wish. The child began to moan occasionally, and attempted to cry; the pulse could be distinctly felt, though irregular; but the eyes continued in the same immoveable state, with dilated pupils, as when I arrived. In addition to the postural movements, &c. &c., cold water was dashed over the head, face, and various parts of the body.

“The child was then placed in a tub of hot water to

the middle of the body, a cloth wet with hartshorn applied over the region of the heart, and cold water poured upon the head. Instead, however, of improving, the breathing became more irregular, and spasmodic in its character.

“The child was therefore, after being five minutes in the bath, removed, and the postural movements repeated and persisted in for half an hour. The breathing again became more regular and natural, the pulse more distinct and firmer, yet the eyes continued in the same state as before.

“It was then evident that, besides the carbonic acid which might be retained in the blood, there was congestion of the brain, or some other state allied to it, which might be relieved by cautious depletion. A leech was fortunately got and applied to the head, with most decided relief, and, after a visit of two hours and a half duration, I had the pleasure of leaving the child in the enjoyment of a sound sleep, and in two days of seeing it quite well, after two or three doses of aperient medicine.

“I could not find out how long the child had been under the water ; all I could ascertain was, that it might have been one minute, but could not be more than five.

“In the case of a still-born child, from breech presentation, on May 4th, 1856, I had the satisfaction of seeing the postural movements successful in restoring animation, after being *persisted in for twenty minutes before the child gave any signs of life.*

“In a similar case, after a natural presentation, on the 28th Jan., I failed in restoring animation, though the

Ready Method was tried for thirty-five minutes. I might have continued the movements longer, but the mother required my attention for some time, and I deemed it vain afterwards to repeat them.

“Until your last number appeared, I had no idea that any man or body of men, gifted with common sense, would have had any doubts of the propriety of following out the treatment recommended by Dr. Marshall Hall, in all cases of asphyxia, from whatever cause. I have therefore contributed my mite to the list of cases already published, confirming the soundness of the views entertained and the treatment recommended by Dr. Marshall Hall, and trust that every medical man will see it to be his duty to follow out the Ready Method on every suitable occasion.”

CASE II.—*By Dr. Hadden, of Skibbereen.*

The second case of success in treating the drowned by postural respiration is by Dr. Hadden, of Skibbereen. I give it in Dr. Hadden's own words, and add two extracts from a correspondence with that able physician :

“ Skibbereen, Co. Cork, July 31, 1856.

“ My dear Sir,—I think it right to inform you that within the last few days I have had an opportunity of trying your new method of inflating the lungs, and I am happy to say the result has been most successful.

“ The case was that of a boy, about thirteen years of age, who, when bathing, got a cramp in the right leg, and, after struggling for a considerable period, sank exhausted. He remained under water for many minutes, and when brought to land appeared quite dead.

“ I happened to be passing at the time, and immediately put your plan into operation, and after continuing it for more than a quarter of an hour, he began to show some symptoms of returning animation.

“ His recovery is the most remarkable I have ever witnessed, and must have been impossible, if treated according to the methods heretofore in use.

“ With much respect, I am, dear Sir, very truly yours,
“ DAVID HADDEN, M.D.”

“ Dr. Marshall Hall.”

“ Skibbereen, Aug. 12, 1856.

“ My dear Sir,—I must rely altogether on the statements of others as to the exact time during which my patient was under water ; but, from a variety of circumstances, I believe he could not have been less than from fifteen to twenty minutes completely submerged after he had risen to the surface for the last time. The account is, that he breakfasted at nine o'clock, and immediately afterwards went to bathe, in company with another boy, about his own age. He had not been long in the water when he complained of cramp in his leg, and called for help to his companion, who immediately went to him, but had not strength to render him effectual assistance,

and with difficulty escaped being dragged to the bottom by him. The alarm was then given, and assistance procured from a distance of at least an eighth of a mile; but when this arrived, the body could not be seen. A man undressed, and dived in the place where the boy was last observed, and, after much trouble, succeeded in bringing him to the surface.

“ I was driving near the place at ten o’clock, and saw the body taken out of the water; and so completely was animation suspended, that even his own father, with other bystanders, thought it quite useless to adopt any remedial measures. However, I immediately spread a woollen cloak on the ground, placed the body in the prone position, and commenced the rotatory movements, having given directions that a careful person should support the head, while others were employed drying and rubbing the legs and entire surface. The sun was very hot at the time, and I left the body uncovered, to facilitate the rubbing. I also held liquor ammonia under the nostrils, and rubbed it over the region of the heart.

“ For fifteen minutes, every exertion appeared useless. There was *then* a kind of respiration established. The breathing soon became loud, and accompanied by a kind of moan, which continued for several hours. At eleven o’clock, there was an attempt at vomiting, which was near frustrating all our exertions, as a portion of food got into the larynx, and had almost produced suffocation. At half-past eleven, he was taken home. From that time, there was some return of consciousness; but during

the entire day he had considerable pulmonary and cerebral congestion; and this was followed by a severe attack of fever, which continued for ten days.

“ I am happy to say he is now completely recovered.

“ I am, dear Sir, very truly yours,

“ DAVID HADDEN.”

“ To Marshall Hall, Esq, M.D. &c. &c.”

“ Skibbereen, Sept. 24th, 1856.

“ My dear Sir,—The idea I had formed of the case was, that vital action had commenced with the deep inspiration and convulsive movements of the diaphragm and abdominal muscles, converting the respiration, which had *previously* been inaudible and purely passive and mechanical, into active and independent breathing; the pneumogastric (stimulated by long-continued artificial respiration) being evidently the excitor. The trifacial could not have had any influence in the first instance, as the ammonia was not used until after the effort at vomiting.

“ I have lately used the rotatory movements with success in the treatment of a still-born infant; but I thought it necessary to increase the weight of the body by gentle pressure, when in the prone position, and smart slapping over the nates to excite vital action.

“ I am, dear Sir, most truly yours,

“ DAVID HADDEN.”

“ To Marshall Hall, M.D. F.R.S.”

CASE III.—*By Dr. A. Legat, of South Shields.*

I have peculiar pleasure in recording, as the third case of the success of postural respiration, the following most interesting one by Dr. A. Legat, of South Shields :

“ Having had occasion to visit a lady, three or four miles distant, on the third instant, as I drove to the door I was requested to go immediately to the coach-house to see “ an extreme case.” On entering the harness-room, I saw, stretched *on his back*, before a warm fire, partially enveloped in blankets, a muscular-looking young man, surrounded by four or five others, one of whom was supporting his head. The lips and face were blue, the surface quite cold, and the body so rigid that the right hand, which rested over the pubis, and the left arm, bent at right angles over the chest, could not without difficulty be changed from their position. No respiration could be detected, and there was no pulse. A slight quivering was observed throughout the body for an instant, and in this movement seemed the only hope that life might be restored. Exactly an hour had elapsed since he was taken out of the sea, and at that time he spoke a few words. Blankets were taken down to the beach. He was well rubbed. An attempt was made to administer brandy, which it would appear he could not swallow, and he was then carried about four hundred yards to the room where I found him. He had been lying here about

half an hour, *during which time he had not spoken*, and for the last ten minutes of it he had been in the condition above described. Those around told me “they feared it was too late to be of use to him.”

I felt there was no time to be lost. The window of the room was ordered to be thrown open, and placing my watch on the floor before me, for the purpose of correct observation, I knelt down, and, with my right hand on his left shoulder and my left on the side of his chest, commenced the movements described by Dr. Marshall Hall. He was rolled gently over on his face (the mouth and nostrils being kept carefully free), and then back again on his side “and a little beyond,” every four or five seconds.

About *seven minutes* had elapsed when I heard more than one of the bystanders say, “it was of no use;” but the movements were steadily *persevered in*, accompanied with occasional *slappings* with the open hand over the back of the chest, and *rubbing* of the limbs upwards by two assistants. *In twelve minutes* I first detected indications of returning respiration, and *in six minutes more*, accurately noted, the breathing was natural. I then made him swallow a little brandy, and saw him again in half an hour, before I left, perfectly safe.

“*Remarks.*—Three months have just elapsed since the short, but excellent rules, from the able pen of Dr. Marshall Hall, for the restoration of the drowned, appeared in *The Lancet*, and now the second instance of remarkable recovery by their means is recorded. I could conceive no case which could put this new method more severely

to the test than the present one. Every attention had been paid to the man from the moment he was removed from the water—warm blankets, continued rubbing of the body, the application of mustard, the administration of brandy, removal to a warm fire, &c.; and yet, notwithstanding all this, instead of getting better, he grew worse, and must inevitably in a few minutes more have been beyond all reach of art. And why? Because his kind and attentive neighbours, although doing their best for him, had been pursuing a plan opposed to his recovery.

Three causes evidently operated against the poor man : 1st. the attempt to give brandy, which he could not swallow ; 2ndly. the carrying him nearly four hundred yards ; and 3rdly. the placing him *upon his back* ; all of which, in his enfeebled condition, must have tended to reproduce and prolong the asphyxia. An hour elapsed, postural respiration was tried, under these disadvantages, and in eighteen minutes the respiration was free !

“ It would be well if the Royal Humane Society would withdraw their old “ Rules,” so liberally scattered about, and replace them with the concise and simple instructions of Dr. Marshall Hall. Ordinary intelligence and perseverance, with a knowledge of such rules, I feel certain, would be the means of saving very many lives.

“ I beg also to suggest to my professional brethren this plan for the purpose of resuscitating patients thrown into a critical condition from the administration of chloroform. The present method of seizing the tongue with

the forceps to pull it forward will be unnecessary, and command over the respiratory organs will be found to be surprisingly great.”

“ November, 1856.”

CASE IV.—*Improperly treated—fatal. By Dr. A. Legat.*

I am indebted for a second case to Dr. A. Legat—full of the deepest interest and instruction.

The little patient was five years old. He *gaspèd* when first rescued from the water, and would surely have been restored by instant postural respiration. Instead of this, the warm-bath was used; the child was lost; at last postural respiration *was* tried; but the state of apnœa had passed into fatal asphyxia!—a sad commentary on a proposition noticed in the foregoing pages.

“ South Shields, June 4th, 1857.

“ Dear Sir,—As I believe you will be glad to hear some particulars of a case where the “ Ready Method” has been tried by me a second time, although unsuccessfully owing to previous loss of time in improper treatment, I beg to forward you the following notes :

“ When visiting a patient on the evening of the 4th ultimo, a messenger requested me to go with him immediately to see a child supposed to be drowned. The house was not a quarter of a mile distant, and as my conveyance was at hand, I saw the little patient within a couple of minutes.

“The room was a small one, and crowded with neighbours. The child was undressed, the lower extremities in warm water, and warm wet blankets were placed over the body, which was quite *flaccid*. The face and lips very livid, the tongue slightly protruding beyond the teeth; a little frothy mucus surrounded the nostrils; and the pupils were considerably dilated. There was no respiration, or pulse.

“He was carried to the door instantly, and treated after your excellent method. I began the movements precisely at eight, P. M.—continued them steadily for about twenty-five minutes, when Mr. Young, another medical man, arrived. We persisted steadily for one hour and five minutes, when it became so dark, we judged it excusable to desist.

“During the movements, small quantities of fluid, with some half-digested food, came from the stomach.

“What had occurred before I saw the boy, I learned subsequently. There was a variety of statements on this point; but the following one, made by the father, seemed most consistent and correct. The little fellow, five years of age, left his nurse about half an hour before I saw him, accompanied with another child, went to a pond about 100 yards off, and fell in almost immediately. He was supposed to have been in the water fifteen or twenty minutes—was taken out by his father, who said he gave two little gasps—and was conveyed to the house, and placed at once in the warm bath. This occupied but a short time; but in the meanwhile the little patient was irrecoverably dead!

“ Who can doubt that the boy would have been rescued by the “ Ready Method,” used *instantly by the side of the pond, where he gasped ?*

“ Believe me, dear Dr. Marshall Hall, yours very truly,

“ A. LEGAT.”

“ Dr. Marshall Hall, F.R.S.”

CASE V.—*By Ernest P. Wilkins, Esq. of Newport.*

My fifth case is by Mr. Wilkins, of Newport. Though briefly detailed, it is also full of interest :

“ Newport, Isle of Wight, March 18th, 1857.

“ My dear Sir,—I have adopted your discovery in several cases with perfect success.

“ A female, aged thirty-two, in a moment of rage, threw herself from a bridge into our river. I was not perfectly satisfied that the asphyxiated condition in which I found her arose from drowning—although it might have done so—because the depth of water was not above the knees. Some of the parties who picked her up said she was not long enough in the water to be drowned ; others said she was drowned. I attributed the apnœa to the shock to the nervous system produced by the fall from the height, from fifteen to twenty feet ; she pitched on the nates ; or to the exposure to cold, it being a bitter night, and she was dragged a long distance in the water

to reach the landing place. It might perhaps arise from combined causes.

“ I was soon on the spot, and in the language of the bystanders found her dead—in other terms, asphyxiated. I commenced your Ready Method, and continued it for upwards of an hour, with perfect success, to the amazement of her friends who assisted me.

“ The other cases were suspended animation from childbirth, of which so many cases are on record.

“ I shall be happy to reply to any questions on the foregoing case, if you may desire further information.

“ Believe me, with sincere respect, faithfully yours,

“ ERNEST P. WILKINS.”

“ Dr. Marshall Hall.”

CASE VI.—*By Mr. Richard Ellis, of Bishops-Auckland, Durham.*

My sixth case is from the able pen of Mr. Richard Ellis, of Bishops-Auckland. It must be a severe case in which convulsion occurs, and great confidence in the means is shown by its second judicious repetition :

“ *To the Editor of The Lancet.*

“ Sir,—On the evening of the 1st of this month, about seven o’clock, I was called to see a boy who, I was told, had just been taken out of a deep pond, situated in a brickfield near this town. I arrived at the patient’s

house just as they were in the act of carrying him in, apparently lifeless. He was a thin, delicate child, between seven and eight years of age, and he presented the following unpromising symptoms :—Respiration entirely suspended ; action of the heart inaudible ; coldness of the entire surface of the body ; pulse imperceptible at the wrist ; great lividness of the face, and turgescence of the superficial veins of the neck. I immediately had the wet clothes removed, and placing the body on a blanket spread on the floor, proceeded to carry into execution the plan recommended by Dr. Marshall Hall for restoration in such cases, turning the patient on his side and a little beyond, making pressure on the spine, and exposing the face and chest to a current of cool air. When I had continued these movements repeatedly each minute *for about half an hour* (at the same time using friction of the body perseveringly), I was delighted to hear one or two gasping attempts at respiration ; and in about *another half hour*, the circulation became so far restored as to admit of his being removed to bed. Here, however, he had a severe attack of convulsions, which continued so long as to compel me to repeat the postural movements for some minutes. The temperature of the body now increased rapidly ; and at the end of two hours from the time of my first seeing him, he became so far restored as to swallow a little, and to be conscious of the presence of his friends. The reaction and consequent fever were moderate, and the boy has now quite recovered from the effects of his accident.

“ From inquiries which I have made since, it appears certain that the child was submerged for at least *five minutes*, as he had to be extracted from the mud in the bottom of the pond by means of a ladder.

“ I remain, Sir, your obedient servant,

“ RICHARD ELLIS, L.R.C.S. Edin.”

“ Bishops-Auckland, Durham, June, 1857.”

CASE VII.—*On board the Dreadnought, by*
F. M. Corner, Esq.

“ Henry Bullivaul, ætat. eleven, fell from a boat into the Thames, immediately became submerged, and was carried by the tide a distance of about one hundred yards, when he became entangled in the moorings of the Dreadnought, ten feet beneath the surface. Allowing the shortest time of submersion, he was under water five or six minutes; and in three minutes more he was on board the hospital.

“ I saw him directly, and found respiration ceased and his face and lips livid, and he was to appearance dead. I did not examine for the pulse, regarding that of little moment, but at once resorted to the “ Ready Method;” at the same time having his clothes removed, and the body rubbed dry. After two or three rotations, there was an inspiratory effort, succeeded, shortly, by others, at intervals of about half a minute. He soon breathed regularly, but faintly, and at long intervals; and during

the intervals I performed artificial respiration, and occasionally applied strong ammonia to the nostrils, and slapped the chest smartly with my flat hand; all, I am satisfied, with benefit. In about ten minutes he was sensible, spoke, and took a few teaspoonfuls of brandy and water, shortly followed by vomiting of apparently Thames water. He now breathed tolerably well, and only complained of cold; and a hot bath being ready, I placed him in it for two or three minutes, giving him a little brandy. After this, he was wrapped in blankets, a mustard cataplasm applied to the front of the chest, and left.

“ F. M. CORNER.”

II. CASE OF SUFFOCATION.

CASE VIII—*Of a Man overwhelmed by the fall of Earth*; communicated by James F. West, Esq.

“ The attention of the profession having been recently called to the mode of performing artificial respiration suggested by that distinguished physiologist, Dr. Marshall Hall, I think it may not be uninteresting to publish the details of a case which, from the severity of its nature, must be considered as an ample test of its merits, as a mode of relieving suspended animation in cases of asphyxia.

The patient was completely asphyxiated, having been covered by a mass of earth for three-quarters of

an hour ; yet perseverance in this method of treatment sufficed to restore him to a state of safety in a comparatively short space of time. From the notes of the case I have made the following abstract :

“ James S——, a stout, plethoric, healthy man, thirty-eight years of age, was admitted into the Queen’s Hospital, Birmingham, under the care of Dr. Heslop, at a quarter to one o’clock in the afternoon, on April 28th, in an almost inanimate state, breathing convulsively and stertorously, the respirations being not more than four or five in a minute, with a scarcely perceptible pulse, the face pale, and the general surface of the body cold and bloodless.

The history of the case, as obtained from his fellow labourers, was, that while he was engaged, about midday, in constructing a sewer, the earth around him gave way, and he was completely buried to the depth of about ten feet. Twenty minutes elapsed before the soil was removed from around his head, and at least three quarters of an hour before the whole of the body was extricated. A cab having been at once obtained, he was conveyed to the hospital. No appearance of injury on any part being apparent, and there being no such evidence as bleeding from the nose or ears to warrant a suspicion of fracture of the base of the skull, but the symptoms being rather such as might be accounted for by the circulation of non-arterialized blood, I determined to put in practice the Marshall Hall method of artificial respiration. With the assistance of my friend Mr. Mould,

by whom the most valuable aid was rendered during the entire operation, the man was stripped, cold water was dashed on his head and face, and the postural movements commenced. Hot flannels were applied to the lower extremities, and friction towards the centre of the circulation unremittingly kept up. During *the first quarter of an hour*, but little improvement was visible; perfect coma existed; not a sound escaped his lips, and there was not the slightest muscular movement; *but during the second quarter*, a marked amelioration of the symptoms took place. The livor gradually left the lips, and the countenance resumed a more natural aspect; the pupils, which were at first much though equally contracted, began to dilate; the pulse, though still intermittent, became more frequent and regular; an attempt at vomiting was made, but nothing but a little water containing gritty matter was thrown up; and lastly, he began to move his arms spasmodically, and by the action of the muscles of forced inspiration to endeavour to dilate his chest. At the end of three quarters of an hour, the pupils were intensely dilated; the skin had become warm; inarticulate sounds began to escape his lips; and the muscular movements were stronger and more frequent.

The breathing, which was still laborious and stertorous, almost ceased, when the patient was laid on his back, and the artificial respiration discontinued.

“ *The Ready Method was unceasingly kept up for an hour and a half*; and at the end of that period the respiration was performed naturally, though slowly, and

with some difficulty. The skin was hot, the face flushed, the vessels of the conjunctiva injected, the veins of the head and neck turgid; the pulse had risen to 70, but was perfectly regular.

“ The patient was then placed in bed, and held in the recumbent posture by two assistants, as he was very violent, and restraint was imperatively called for. Venesection to the amount of twelve ounces was now performed; the blood, which came in a good stream, was quite black, but became florid on exposure to the air. The respiration was much relieved by this procedure, and subsequently took place with greater regularity, less stertor, and diminished effort. He still continued to writhe about in bed; but his efforts were much less violent: warmth was kept up by hot blankets, &c. Towards eight, P. M. the breathing again became slow and laboured, and the pulse fuller and more frequent. By the advice of Dr. Heslop, twelve leeches were applied to the temples, and the bleeding encouraged by hot fomentations. Respiration was now performed very quietly and regularly; the pulse was natural; but there was no sign of consciousness, and he lay apparently in a state of stupor, muttering incoherently at intervals, and picking the bed-clothes. About nine P. M. he passed a stool involuntarily. At eleven P. M. an enema, containing half an ounce of turpentine, two ounces of castor oil, with half a pint of gruel, was administered. and followed by a copious evacuation.

“ The patient slept pretty soundly during the re-

mainder of the night, and on awaking, about eight in the morning, he recognized his wife, who was standing by his bedside, though he was unable to answer questions pertinently, and remained in a state of semi-consciousness during the rest of the day. He continued heavy and lethargic, complaining considerably of headache, during the two following days; and he was not perfectly rational till Saturday, May 2nd, when, his state being such as to warrant his discharge, he was permitted to leave the hospital."

III. CASES OF STILL-BORN INFANTS.

CASE IX.—*By Marshall Hall Higginbottom, Esq. of Nottingham.*

The following case possesses a peculiar value, on account of the accuracy with which it was observed; and especially from the fact, first noticed by the author, of bubbles of mucus blown out and drawn into the nostrils—a sort of natural Pnœometer. It was particularly noticed afterwards by Mr. Charles Vaudin and Dr. Nicholls. It is of great moment to be able to observe that there really *are* expiration and inspiration in pronation and rotation; for it is of vital importance to know that the air-passages are *free*:

“Carlton Street, Nottingham, Dec. 21st, 1856.

“My dear Uncle,—* * * * Early this morning I attended a lady in her confinement. The presentation

was a breech one, and there was much and unavoidable pressure upon the umbilical cord, which ceased to pulsate a quarter of an hour before the child was born. When born, the child was quite livid, without perceptible movement of the heart, and indeed to all appearance dead; and, under ordinary circumstances, I should not have entertained the slightest hopes of its resuscitation. By adopting your method, I had the great satisfaction of seeing it fully restored to life in about twenty minutes, when it cried lustily—the nurse and friend being amazed at the result. Being the only son in a large family of daughters, the parents' delight was proportionately great. I explained to the father that he had to thank you for a living son. * * * *

“ Believe me, my dear Uncle, your affectionate nephew,

“ MARSHALL HALL HIGGINBOTTOM.”

“ Dr. Marshall Hall.”

“ Carlton Street, Dec. 25th, 1856.

“ My dear Uncle,—I lose no time in sending you a more particular account of the phenomena observed in the case of the still-born infant which I mentioned to you.

“ The child was livid, and the lips purple, and there was no perceptible action of the heart.

“ Upon commencing the postural treatment, I noticed that *with each induced expiration a quantity of air, denoted by bubbles of tenacious frothy mucus, issued from*

each nostril, the bubbles receding on induced inspiration.

I saw the necessity of this mucus being removed each time, in order to allow the free entrance of air, respiration being apparently carried on entirely through the nostrils; for although there was mucus also between the lips, it was not at all disturbed during the postural changes.

“ Continuing the treatment for about ten minutes, the mucus ceased to flow, and a very slight action of the heart became perceptible. This ceased, if there was any remission of the treatment; but returned when the postural proceedings were renewed.

“ In fifteen minutes the action of the heart became stronger, and dashing cold water upon the face and chest now produced a forcible inspiration; after which, and for the first time, respiration appeared to be carried on through the mouth.

“ The countenance, which had gradually become less livid, now assumed a natural appearance, and in twenty minutes the child was quite restored, and cried vigorously.

“ Your affectionate nephew,

“ MARSHALL HALL HIGGINBOTTOM.”

“ Dr. Marshall Hall.”

CASE X.—*By Charles Vaudin, Esq. of St. Helier's, Jersey.*

“ 60, New Street, St. Helier's, Jersey, Feb. 10th, 1857.

“ Dear Sir,—Truly has it been said that medicine in judicious hands is the handmaid of Nature.

“ As truly may it be said that your thoughtful and ingenious application of great principles and natural laws to the treatment of diseases and accidental exigencies must be ranked amongst one of the greatest discoveries of modern medical science ; for they have, since the short period of their first promulgation, been the means of saving many lives that would have been otherwise lost.

“ The enclosed I have thought worthy of record, as exemplifying in a remarkable degree *the truth* of the *principle*, as well as the *success*, of the “ Marshall Hall Method.”

“ The desire of adding testimony to a great truth, which, like all others, is too slow in being received and appreciated, and the wish of seeing honour given to whom it is due, are the only apologies I have to offer for addressing you.

“ Believe me to be, Sir, yours very truly,

“ CHARLES VAUDIN, M.R.C.S. &c.”

“ Dr. Marshall Hall.”

“ Mrs. D——, a lady of exceedingly delicate constitution, aged twenty-six, was taken in labour of her second

child on the second of January, at seven A. M. She had suffered trifling pains two days before, and had not felt the motion of the child since they commenced. I saw her at nine, and found her then suffering from frequent but ineffectual pains. The vagina and external parts were hot and dry; the os uteri dilated to the extent of a shilling; its lips thin, dry, and unyielding; membranes entire; and head presenting. A careful stethoscopic examination of the abdomen failed to detect any sounds of the fœtal heart. The pelvis was small, but not deformed.

“At seven A. M. on the 3rd, I delivered her of a delicate male child. Around its neck were two folds of the funis, in which I could not detect the slightest pulsation. It was cut and lightly ligatured. The surface was flaccid, cold, and very livid; the lips blue; the palms, soles, and a small surface over the nates, were quite sodden, and partially exfoliated. Entire absence of all reflex action. The pupils were insensible to light, the nose to ammonia, and there was not the slightest appreciable motion in the præcordial region. The usual remedies, except sufflation and the hot bath, were tried without success. Suspended animation could hardly be more pronounced or akin to death.

“The “Marshall Hall Method” I persevered in for twenty-six minutes, accurately noted by my watch before me. The postural movements were made upon warm blankets frequently changed. Then the funis began to bleed; about one drachm of blood was lost, and it was

secured. The countenance had before this undergone a marked change, had become mottled and red. My observations of the respiratory action coincided exactly with Mr. M. H. Higginbottom's; viz. "with each induced expiration, a quantity of air, denoted by bubbles of a tenacious frothy mucus, issued from each nostril, the bubbles receding on induced respiration." I could now distinctly discover a slight fluttering action of the heart. After twenty-nine minutes, and following an induced expiration, I noticed a tremor of the skin and muscles over the epigastrium, followed by a sudden voluntary inspiration, the chest becoming forcibly distended and fixed, rendering its diaphragmatic boundary tense, and, as well as itself, resonant as a drum all over. The chest remained in this fixed position for nearly two minutes, the intercostal muscles being very prominent, the postural motions still going on, and I began to think all my efforts ended here, when the child made a voluntary expiration, attended by a cry; the movements and frictions were made with redoubled energy, and I soon had the gratification of hearing the infant cry loudly enough, and breathe alone, as well as empty its bladder vigorously, thirty-three minutes having elapsed. The door and a window of the room were kept open, and the process carried on near the former, to ensure a supply of fresh air. The child has been subsequently dry nursed, and is doing well."

CASE XI.—*By Dr. Nicholls, of Wiveliscombe, Somerset.*

“ Wiveliscombe, Somerset, Feb. 6th, 1857.

“ Dear Sir,—With much pleasure and satisfaction I send you a very short account of a case of asphyxia in a new-born infant, treated by your invaluable plan.

“ On Tuesday, February 3rd, at four p. m. I was called some miles, through frost, snow, &c. to a poor woman who had been in labour three days, and who, strange to say, out of eight labours, has five times had arm presentations, and twice placenta prævia. I found *part* of the placenta and *both arms* presenting, and, after very great exertions, delivered her by turning of an apparently *dead* child. For three or four minutes I was so much engaged with the mother, who was in a state of great prostration, that the child was not attended to. I then treated the child on your plan, although with very faint hopes of success; but *after rather more than half an hour's* exertions, much to my satisfaction, and to the nurse's and mother's astonishment, circulation and respiration were as strong as I ever saw in a new-born child. I feel quite sure that hot water, friction, brandy, &c. would have been useless in this case.

“ Mr. M. H. Higginbottom's case was very much like mine; as I noticed the frothy mucus which came from the nostrils; and this gave me great trouble, as the nurse would give me no help in a case which she thought hopeless. I may add that I saw the little patient this

morning, and she is as strong as any child of three days old.

“ The weather was very cold, and I quite think with you that cold protracts latent vitality, and gives you a greater chance in these cases.

“ I am, dear Sir, yours very truly,

“ JAMES NICHOLLS, M.D.”

“ Marshall Hall, M.D. F.R.S.”

CASE XII.—*By J. T. Savory, Esq. of Wendover.*

“ *To the Editor of The Lancet.*

“ Sir,—If you think another case of asphyxia, successfully treated by the “ Marshall Hall method,” worthy of notice, please to give it a corner in your widely circulated journal.

“ At three o'clock A. M. on December 29th, I was called to a case of placental presentation. On arriving at the house of my patient, I found her in an alarming state of syncope, from excessive hæmorrhage. I immediately attempted delivery by turning; the child (a boy) being large, I had a good deal of difficulty in liberating the head from its pelvic prison, some considerable time and much exertion on my part being required, the mother having no uterine pains to assist in the expulsion.

“ When the child was born, I observed it was perfectly asphyxiated; but my chief anxiety being to do all I could for the mother, my attention was not directed to

the infant for several minutes. It then appeared quite inanimate. However, thinking it a good opportunity to try "Dr. Marshall Hall's method" in cases of asphyxia, I proceeded according to the plan laid down by him, and after persevering unremittingly for *a quarter of an hour*, the child gave a slight and short inspiration; and in three minutes more, another inspiration took place; after this, the infant breathed once in a minute for a short time, and then more frequently and deeply; at length he opened his eyes; and at the expiration of *half an hour*, he breathed freely, and cried as strongly as a healthy child.

"Two female friends of the patient were present, and they frequently expressed a positive opinion that it would be perfectly useless to continue any attempts at resuscitation, the nurse at the same time exclaiming, "Ah, Sir, you may turn and twist that child about as much as you like, but you will never bring it to life." Their surprise was great indeed when at length the child began to show signs of animation.

"I take to myself no credit in the treatment of this case, being merely an humble follower of the scientific and valuable directions given by Dr. Marshall Hall.

"I am, Sir, your obedient servant,

"J. T. SAVORY."

"Wendover, January, 1857."

CASE XIII.—*By J. C. Chappell, Esq. George Street,
Hanover Square.*

The interest attached to the present case is in the fact of the infant being born prematurely, at six months and a half. It was restored to *life*, even although scarcely likely to *live* :

“ The child was still-born ; no pulsation at the wrist or beating of the heart to be detected. I pursued your plan steadily for fifteen minutes (the nurse evidently thinking me a lunatic) ; at the end of which time, I found the heart beat, and, in five minutes more, heard as loud a cry as could be expected from a 6½-months’ child. The infant still lives ; but that it may be reared, appears very improbable.

“ I found no difficulty whatever in applying the postural changes to the infant in question ; in fact, its diminutive size rendered the operation easier ; a second person performed the frictions upwards.

“ I commenced by clearing the mouth and fauces of mucus, which abounded and afterwards came away in considerable quantities. The child, at its birth, had a dusky hue. For thirteen or fourteen minutes, I found no sign of vitality ; but in one or two minutes more, I felt a slight quiver under my right hand (which grasped the left side of the chest), and almost simultaneously heard a mucous rattle in the throat ; an instant after, I

could discern pulsation of the heart. I again cleared the mouth and throat of mucus, continued the postural movements, and, at the expiration of four or five minutes more, the infant gave a cry as loud as could be expected, considering it was *at most* a seven months' child."

ADDITIONAL CASES.

CASE XIV.

" Bognor, Sussex, January, 1857.

" Dear Sir,—Having read in The Lancet your valuable method for the restoration of the drowned, I resolved to try it in the first case of suspended animation which might come under my care.

" On the 26th of December last, I was called to attend Mrs. —, in labour with her first child ; and on making an examination, I found the operation of turning was required, which I performed. When the child was born, I found it was perfectly asphyxiated. I immediately commenced your resuscitation process, and having continued it for about ten minutes, the nurse observed (to use her own words), " It's no use your trying any longer, Sir ; it's dead enough."

" Being determined to give the process a fair trial, I continued it for about twenty minutes, when the child gave evidence of life, and shortly after cried out ; respiration was established. The child lived fourteen days, and died from debility, the woman not having gone her

full time ; which tends to strengthen the superiority of your process over every other for the restoration of still-born children.

“ I make no apology for sending you this case, believing that you will be pleased with the successful treatment of it, for which I am indebted to you.

“ I am, Sir, your obedient servant,

“ CHARLES OSBORN, M.R.C.S.”

“ Marshall Hall, Esq. M.D.”

CASE XV.

“ *To the Editor of The Lancet.*

“ Sir,—Considering it the duty of all who have tried with success Dr. Marshall Hall’s method for recovering new-born infants in whom all respiration has ceased, to communicate the result of their experience to the public, I am induced to forward the following case :

“ Last Sunday morning, I was called to attend Mrs. M——, in labour. After a short time, the child was born, and duly handed over, alive and apparently well, to an attendant. For some time I was rather anxiously engaged with my patient, who was very much disposed to hæmorrhage (from which she suffered seriously after her last labour). Having seen every thing right and safe with her, I was attracted by the quietness of the infant, when, upon looking at it, I found all respiration had ceased. I instantly commenced Dr. Marshall Hall’s

method, with the happy result, in ten minutes, of delivering up to the friends the infant alive and crying.

“ Apologizing for trespassing on your columns, I am, Sir, your obedient servant,

“ H. S. CHAVASSE.”

“ Sutton Coldfield, Jan. 19th, 1857.”

CASE XVI.

“ Winslow, Bucks. January 30, 1857.

“ Sir,—A case occurred in the practice of Mr. Denne, in this town, last night, illustrating the great advantages of your Ready Method. In a case of confinement, after a very lingering time, the delivery was completed by forceps. When the child was born, there was an immense scalp-tumour, and the usual symptoms of prolonged asphyxia were present—so much so as to cause a doubt in my mind whether even your Ready Method would perform almost a miracle, and resuscitate the child.

“ However, I placed the child in the prone position, and then commenced turning it with the right hand on the side of the chest, the left supporting the head. The movement was repeated about once in a second (such as is marked by the pendulum of a large clock), and after its repetition about twenty-three times, I had the satisfaction of hearing a cry, at first faint, but not by any means so afterwards.

“ The time which elapsed from the first movement to the cry was about seven or eight minutes ; and I may add, that the cord was cut prior to the child being touched, and that no other means whatever were tried but the rotatory motion. The astonishment of the women around the bed was excessive, and they firmly believe that a method will be found almost to return the dead to life. The child is alive and well, and adds another name to the list of lives that have been, and will be, saved by the Ready Method.

“ I have the honour to be, Sir, your obedient servant,
“ THOMAS NEWHAM.”

“ Marshall Hall, M.D.”

CASE XVII.

“ *To the Editor of The Lancet.*

“ Sir,—Within the last three weeks, I have had two opportunities of trying the Ready Method in the asphyxia of newly born infants. One was a case of turning, on account of arm-presentation ; the other was a presentation of the breech. In both instances, the heart’s action was barely perceptible ; no pulsation could be felt in the cord, and no inspiratory effort could be detected. After rotating the trunk five or six times, inspiration commenced, and in a short time respiration became fully established, so that the children were able to cry vigorously. I purposely abstained from using any other means

of resuscitation. My experience of these two cases would, as far as it goes, lead me to consider Dr. Marshall Hall's method as far more prompt and effectual than any of the means which we had previously been accustomed to use.

“ I am, Sir, your obedient servant,

“ J. G. SWAYNE,

“ Physician-Accoucheur to the Bristol General Hospital,
and Lecturer on Midwifery at the Bristol Medical School.”

“ Clifton, March, 1857.”

CASE XVIII.

“ Gainsborough, Feb. 7th, 1857.

“ Sir,—I have much pleasure in adding another to the list of lives saved by your valuable discovery. The facts of the case are as follow, and in some respects similar to one reported in to-day's *Lancet* :

“ I am assisting a practitioner in this town, and on Thursday evening last, the 5th instant, I was called to a woman in labour at the workhouse. On my arrival, at half-past eight P. M. I found the head presenting, and with it a loop of the funis, the pulsation of which had entirely ceased. I found it impossible to replace it, and in half an hour the woman was delivered of a child apparently quite dead. The usual means failing to restore it, I at once commenced the Ready Method. After ten minutes' trial, the child gave a feeble gasp, and it continued to do so at every ten or twelve turns. The inter-

vals between these respiratory movements soon became shorter and shorter, and in half an hour it breathed of its own accord. It appeared, however, in a semi-comatose state for some time, and was three hours before it became warm and could move its limbs. Even then, the heart beat very feebly, and at only half its normal frequency at birth; and it did not entirely recover until six o'clock the following morning. At the present time the child is doing well, and is as likely to live as any other new-born infant.

“Should you desire more minute particulars, I shall be happy to furnish them, and am, Sir, yours faithfully,

“EDWARD CAPRON, M.R.C.S. & L.S.A.”

“Marshall Hall, M.D. F.R.S.”

CASES XIX and XX.

“17, Paddington Green, Feb. 10th.

“Dear Sir,—I take the liberty of communicating to you two cases in which your Ready Method was employed with perfect success. In the first case, the child had been born suddenly; for nearly ten minutes before my arrival, the umbilical cord was twisted round its neck, and the soiled clothes of the mother completely smothered it. The usual remedies of dashing cold water, &c. failed to restore it, and after five minutes your Ready Method was employed. In a few minutes the child gasped, and eventually slowly recovered.

“The second case was a nates presentation in a primipara: the head occupied seventeen minutes in passing; there was great lividity in the face and neck, and no pulsation could be detected in the heart or cord. Perseverance with the Ready Method for several minutes was crowned with success. The child is now nearly two months old.

“I certainly think that in the “olden time” these cases would have been turned over to the sexton.

“I am yours obediently,

“J. S. BEALE.

“Dr. Marshall Hall.”

CASE XXI.

“Detroit, Michigan, U. S. April 1st, 1857.

“On the 18th of January last, I was called to a young married woman, in her second confinement. The presentation was a footling one; and previous to the birth of the child, all circulation in the funis had ceased for over twenty minutes, from the pressure exerted upon it between the parts of the mother and the head of the foetus. Upon expulsion there was complete asphyxia. The face, lips, &c. were perfectly blue, and there was not the slightest sign of animation. Without waiting to cut or tie the funis, I immediately adopted the postural method recommended by you, inducing artificial respiration, causing that act to be performed about twenty to

twenty-two times in the minute. In less than one minute, the blueness of the face and extremities had sensibly diminished; in two minutes, it had nearly gone; in two minutes and a half, a slight effort at natural respiration, accompanied by a sob, took place; and in less than three minutes and a half, respiration was fully established, the child crying lustily. Only one hour elapsed from the time I entered the house till mother and infant (a fine, stout boy) were both comfortable and doing well.

“ I conceive it to be the duty of every one who has a case of this kind to report it to you, so that an accumulation of proof of the efficacy of this beautiful life-giving process may at once be made universally known to the professional as well as non-professional world.

“ WILLIAM COWAN, M.F.P. & L.G.”

CASE XXII.

“ Hamilton, Canada, West, March 20th, 1857.

“ Sir,—On the 24th of August last, soon after reading your first paper in *The Lancet*, I had an appalling case of placenta prævia. Hæmorrhage continuing after the birth of the child, extraction of the placenta necessarily preceded attention to the infant, who was about being removed as dead by the nurse, who had tied and cut the cord. It occurred to me, fortunately, to try your method, believing it applicable to the case of apnœa before me; and after persevering for at least ten minutes,

respiration was fairly established, to the astonishment and delight of all present, and the child is now a fine thriving boy. Since then, in two cases of still-born children, though not so hopeless, I have easily succeeded in restoring animation by the same method.

“ H. CRAGIE.”

“ De Marshall Hall.”

CASE I.—*Of Danger from Chloroform—restored
by Charles Hunter, Esq., of St. George's.*

Life, in the following case, was preserved by Mr. Hunter's promptness and energy. I cannot say how deeply I feel indebted to that gentleman for this and many other instances of his invaluable aid in this inquiry.

“On the 28th of January, 1857, I was asked to assist at the operation of tenotomy, in a little boy about four years old. Chloroform was administered, and everything went on well. The operation was concluded; they had ceased giving chloroform, when suddenly the child became perfectly pallid, and apparently lifeless; respiration had ceased. Warm water, cold water, slapping on the face, were had recourse to; none of these *excited* respiration in the least. Pressure on the sides of the chest was tried, the child remaining in the supine position. This attempt to produce *artificial respiration* was no more effectual than the previous efforts to *excite* respiration had been.

“The child was now quickly placed in the *prone* position, and slight pressure was made on the back ; then rotation on to the side and a little beyond was effected. A gasping movement of the mouth followed. The pronation and semi-rotation were repeated three or four times, when respiration was distinct ; but being still feeble, semi-rotation and pronation were continued a few more times, with much improvement in the respiration. The inhalation of ammonia with a little sprinkling of water were employed ; the latter now excited inspiration. They were repeated occasionally till the child showed that it had regained the full power of its lungs by crying, and it was then given into the mother’s arms.

“In this case it may be remarked that the Ready Method was not adopted at the very beginning ; it might not have been necessary, and we should not have been able to prove that it was. The case was, however, far otherwise. To the pale and apparently lifeless child various excitants of respiration were applied without effect ; also artificial respiration was employed in the *supine* position, by the lateral compression of the thorax. This was not attended by the slightest success, and why ? Dr. Marshall Hall has shown that the tongue may fall back, and that fluids may accumulate in the pharynx and obstruct the orifice of the larynx in this position. If the patient is to breathe again, the only remedy is to cause the fluids to flow out, and the tongue to fall forwards ; and this, it appears to me, can only be effected by the prone and postural method.

“I once saw a patient in one of the London hospitals die under chloroform, before the operation for which it was the preparation could be commenced. In that case, I saw excitants of respiration employed; I saw mechanical attempts made to restore respiration in the supine position, by lateral compression and relaxation of the thorax. Up to this point, the case closely resembles the preceding one. Both failed thus far. The patient, a woman, died (the Ready Method was not then known). Galvanism was applied, and there was nothing else to try. But in the case of the little boy it was known—it was tried—he was saved.

“I will only add this : chloroform constantly makes patients sick during and after its administration. Now, whether matters are really *vomited* or not, may it not be that attempts at artificial respiration in the supine position (in asphyxia from chloroform) have sometimes failed because of the obstruction of the larynx and glottis by the regurgitation of fluids from the stomach into the pharynx? May not even the spasmodic cough which occurs be due to irritation from the presence of these “foreign matters?” Is not, therefore, the Ready Method specially indicated in these cases? for how can any position but the prone remove these life-destroying liquids and morsels?

“I once attempted to resuscitate a still-born child. I had a hot-bath ready, and dipped the infant in and out. I tried other means of inducing respiration. Knowing at that time no better way of effecting this, I applied my

mouth to its mouth, whilst it was in the supine position. I inflated the lungs certainly by the force I employed ; I tried also lateral compression and relaxation of the thorax. Every time I ceased inflating the lungs, thick grumous fluid freely escaped from the mouth. My efforts were useless, and I now believe I blew much fluid with air into the lungs, existing as it did in the pharynx and mouth.

“In cases of drowning, in still-born infants, in cases where chloroform has caused asphyxia, fluids more or less tenacious, according to circumstances, do, then, obstruct the glottis ; and in such cases no attempt to restore respiration can be effectual till the prone position has removed the obstruction.”

“Feb. 1857.”

CASE II—*Of Danger from Chloroform,*
by Wm. Curran, Esq.

“To the Editor of The Lancet.

“SIR,—Admiring the zeal and perseverance with which The Lancet continues to advocate that interesting discovery of Dr. Marshall Hall, which is, I believe, from its simplicity and readiness, likely to supersede the means hitherto employed for the relief of apnœa, and which, in consequence, has been so appropriately termed the “Marshall Hall Method,” I wish to communicate a notice of the following case, in which it was practised

with immediate benefit, and to recommend its adoption under similar circumstances.

“Thos. F——, aged 54, labourer, a thin, spare man, of weakly habit, languid circulation, and having well-marked arcus senilis of both eyes, was brought to this hospital on the 6th of April, having just sustained compound fracture of one toe (which was soon after removed), and such contusion and injury of the other, especially of the large one, as to impair its vitality, and lead to the supervention of sloughing and partial denudation of bone.

“Gangrene destroyed the whole of the upper horizontal half of the great toe. Mr. de Méric, therefore, had to operate in such a way as to turn up the extremity of the lower horizontal half towards the dorsum of the toe to a point where some skin had been left, a portion of the plantar aspect becoming anterior and superior, the toe being thus newly capped after the removal of the last phalanx. The patient was put under the influence of chloroform in the ordinary way, and kept in a state of unconsciousness for about, or perhaps somewhat longer than, the usual period, without manifesting any peculiar susceptibility, or other symptom of a suspicious nature, until after the toes were dressed and preparation made to remove him to bed. At this time, the breathing rather suddenly fell, and became almost imperceptible; the chest-play was so limited and imperfect, and the pallor of countenance so expressive of prostration and approaching syncope, as to require douching, sufflation, pressure over diaphragm, and other means. These not

influencing the respiration, Mr. de Méric seized him by the body, while I held the head, and turning him alternately on his side and chest, soon produced the desired result ; the *very first turn* being accompanied with a puff, which gradually became more whiffing and prolonged, was followed by a muffled groan, and ultimately terminated in deep and tranquil breathing.

“The change was so rapid and obvious as to attract our immediate attention, and impress us with the conviction of its extreme value and necessity in cases of threatening asphyxia from chloroform, drowning, or other analogous cause.

“I am, Sir, very respectfully,

“WM. CURRAN.”

“Royal Free Hospital, May, 1857.”

NOTE III.—*Case of Danger from Chloroform.*

“Chloroform was administered to a man affected with strangulated hernia, to prepare him for the operation; asphyxia was produced; neither respiration nor pulse was perceptible; pronation and rotation, frictions of the limbs upwards, the inhalation of the vapour of ammonia—all the measures comprised in the ‘Ready Method,’ in a word, were effectually administered; the patient recovered, and so recovered that the operation was performed.”

*Note on the Fatal Case of Chloroform,
by James Paget, Esq.*

I do not think medical records contain anything more admirable for prompt candour and intrinsic value than Mr. Paget's case of a fatal result from the administration of chloroform. The case is as follows:—(I have marked in italics those words to which I would draw particular attention.)

“The patient was a boy, nine years old, of delicate constitution, and of nervous, timid disposition; but with no indication of any organic disease, except that for which the operation was to be performed—namely, a tumour of the scapula; for which it was proposed to remove the greater part of that bone.

“At half-past eight, A.M., on February 28th, after the patient had passed a night of sound sleep, the chloroform was first administered in a room adjoining that in which the operation was to be performed. He was alarmed at the thought of being put to sleep, and of what would then be done, and was very averse from taking chloroform; but he was persuaded to inhale it; and, though not without resistance, yet with less than is commonly made by patients of the same age, he was brought under its full influence in about three minutes. He sat in bed during the first few inspirations, and after these, was recumbent. It was observed that two or three deep inhalations were quickly followed by complete insen-

sibility; and the next few inspirations were *stertorous*. He was at once carried, in the horizontal posture, into the room, and laid on the table arranged for the operation.

“Three or four minutes passed while we were arranging his position and his dress, and while I was pointing out to those who were to assist me the proposed plan of operation. During this time the influence of the chloroform so far passed off, that he became sensible, displaced his coverings and pillows, said something expressive of discomfort, and vomited a small quantity of frothy fluid. (He had taken no food since the previous night, when he had had a good supper.) A very small quantity more of chloroform was slowly inhaled, and he became again nearly quiet, and was again placed on his side. I was on the point of commencing the operation; but as he again, by movements, indicated some degree of sensibility, and changed his posture, about forty drops more of chloroform were poured on cotton wool, inclosed in a fold of lint—an inhaler, with the chloroform on sponge having been previously used. The lint was held, about half an inch from the face, by Mr. Thomas Smith, my usual assistant in operation. The patient inhaled lightly for a few times, then made one long inspiration, and appeared to pass at once into deep sleep. Except that he thus appeared to come suddenly under the full influence of chloroform, no external change was visible; but a few seconds later, his *pulse*, which had been carefully watched, and had been to this time normal,

suddenly began to beat very quickly; then it *ceased* for two or three seconds; then beat rapidly for several times, with a kind of flickering movement; and then *ceased* to be perceptible.

“Just before this change of the pulse was observed, the chloroform had been withdrawn. The one deep inspiration was followed by a few *stertorous* breathings; but after these, he breathed naturally, his complexion and features showed no change, he seemed only calmly asleep, and in this state he continued *breathing naturally*, and with no change in his appearance, but *pulseless* for at least a minute. Then his breathing became less frequent, and seemed as if it might soon cease; his face grew pale, and his lips very slightly livid.

“With the help of cold water sprinkled on his chest and face, and cold air blown on his face and throat, he was raised from this state of defective breathing in about two minutes, and again breathed deeply and freely, though slowly (probably about twelve times in the minute). He *thus breathed* for two or three minutes, and during this time the lips, and the pale or slightly livid parts of the face, became pink again, and though *no pulse could be felt* at the wrists, the heart was heard acting. During this time also, some wine and brandy were poured into the mouth, and passed down the œsophagus, but without any evident movements of swallowing. His breathing again became gradually infrequent and feeble. Cold air and sprinkling with water, frictions and percussions of the chest, scarcely increased the

breathing, and in less than two minutes it ceased. Artificial respiration, by the method of Dr. Marshall Hall, was immediately employed, and many times during the first five minutes of its employment the artificial inspiration obtained, when turning the body over to its side was followed by a distinct, and sometimes even a full muscular inspiration. But at the end of about five minutes these signs of life ceased, fæces escaped, and no more indications of life appeared, though the artificial breathing, the friction of the limbs, and other means for resuscitation, were continued for twenty or more minutes."

On reading this interesting case, I wrote to Mr. Paget, and, amongst others, my letter contained the following paragraph :

" My own idea is, that the case was not at all one of pure *apnœa*, or likely to be benefited by the induction of respiration. The *stertor* and other defects in breathing were obviously the effects of *narcotism* of the medulla oblongata. The absence of pulse, or suspended circulation, the breathing continuing, establishes *asphyxia* not the result of *apnœa*. Of these and of final *sinking* the patient seems to have died, the *apnœa* being the general *result*—the *effect*, not the *cause*, of dying."

Mr. Paget's reply corroborates my view :

" I fully agree with you as to the cause of death in the case I have recorded. If the poor boy's danger had been due to asphyxia (suffocation), I feel nearly sure that he would have been saved by your method of artificial respiration. I was struck with its equal *facility* and

effectiveness as the remedy of ordinary asphyxia; but I felt, while using it, that the case was one in which it could do no more than secure that respiration should not be wanting if the heart should recover its power. My belief is, that from the time of the cessation of the pulse, though the heart could for some minutes be heard acting, there was no current of blood, no true circulation; and that the boy ceased to breathe because his blood ceased to move.”

These documents establish several new facts: first, that the efficiency of *postural* movements for inducing respiration is perfect; secondly, that, as there may be asphyxia the *effect* of apnœa, so there may be apnœa the *effect* of asphyxia; thirdly, that in the former case only, it is to be feared, can artificial respiration be of any efficacy.

March 17th, 1857.

Note on Dr. Snow's Experiments.

“To the Editor of the Lancet.

“SIR,—Subsequent to my note on Mr. Paget's interesting case, I have had my attention particularly drawn to Dr. Snow's paper on “The Cause and Prevention of Death from Chloroform.” I especially allude to the paper printed from the *London Journal of Medicine* for April, May, and June, 1852.

“I have no hesitation in affirming that the first

three pages of this paper are amongst the most able and valuable in physiology, and I beg to be allowed to reproduce them in the pages of the *Lancet* :—

“ ‘Chloroform, like other medicines which relieve or prevent pain, is capable of causing death if its action be carried too far. When a certain quantity of it is present in the blood, sensibility is so far diminished that surgical operations may be performed without pain; whilst a certain additional quantity has the effect of diminishing sensibility to such an extent, that the necessity for breathing (?) is no longer felt, the respiratory movements cease, and the circulation of the blood is by this means soon arrested. In some cases, as we shall see, sufficient chloroform is absorbed to arrest the action of the heart by its own influence.

“ ‘When animals, such as dogs, cats, rabbits, and guinea-pigs, are made to respire air containing from three to five per cent. of chloroform till they cease to breathe,—a process which generally occupies ten or fifteen minutes,—the heart can be heard to beat, by means of the stethoscope applied to the chest, for a minute or longer after the breathing has ceased; and it often happens that, about the time when the heart’s action fails, the animal makes two or three gasping inspirations, which have the effect of restoring the contractions of the heart, which recommence with great rapidity. If the animal has been withdrawn from the chloroform, these gasping inspirations have generally the effect, when they occur, of thoroughly re-establishing both the breathing

and circulation ; but if it is made to breathe the chloroform during these gasps, the action of the heart is again arrested, and the natural breathing does not return.

“ ‘ When the same kind of animals are made to respire air charged with upwards of eight per cent. of vapour of chloroform, death occurs with great rapidity, and in a different manner from that just described. The action of the heart ceases about the same moment as the breathing. In three instances, indeed, it has ceased before the breathing, and although gasping inspirations have several times occurred after the chloroform was withdrawn, it has rarely happened that these inspirations have had the effect of restoring the heart’s action.

“ ‘ I have observed the manner in which the breathing and circulation ceased in twenty-nine instances, with the stethoscope applied to the chest of the animal, when the quantity of chloroform in the air they breathed was known ; but the following three experiments will suffice to show the different ways in which death occurs under the influence of chloroform, according as its vapour is more or less diluted with air. I may here remark, that the results of the experiments mentioned in this paper can be applied with great propriety to elucidate what occurs in the human subject, both on account of the exact similarity between the effects of chloroform on the lower mammalia and on man, when confined within safe bounds, and also from the close resemblance of the phenomena caused by the less diluted vapour, to what has been described as occurring in the accidents to patients.

“ ‘Experiment 1.—A young but full-grown cat was placed in a glass jar, of the capacity of 1600 cubic inches, and a fluid drachm of chloroform was introduced, by a portion at a time, through a tube in the cover of the jar. As twenty-five minims of chloroform produce twenty-six cubic-inches of vapour, the atmosphere which the cat had to breathe contained nearly four per cent. of vapour, and the jar was moved about to ensure the uniform mixture of the vapour with the air. In five minutes the cat became insensible, and lay breathing naturally. In about ten minutes more the breathing became very feeble, and it ceased altogether in about another minute, or sixteen minutes after the cat commenced to breathe the chloroform. It was immediately taken out and laid on a table, and the stethoscope was applied to the chest. The heart could be heard beating distinctly at first, but the pulsations became slower and feebler, and in about a minute they could be no longer heard. Just at this time, however, the cat took a gasping inspiration, and immediately the heart was heard to beat in a most rapid manner. The gasps were repeated, and the action of the heart, became less rapid, but stronger. In a little time both the breathing and the action of the heart became natural, the cat remaining, however, insensible for some minutes.

“ ‘Experiment 2.—A cat, of about the same size as the last, was put into the same jar, and the same quantity of chloroform was introduced. It was removed at the end of four minutes, when it was so far insensible as to

offer no resistance. Being laid on the table, it was made to breathe air charged with ten per cent. of vapour of chloroform from a bladder. Twenty-five minims of chloroform were put into the bladder, which held 250 cubic inches, and it was filled up with the bellows. A portion of another bladder, which was attached to the stop-cock, was made to surround the head of the cat, and it consequently breathed to and from the bladder. In half a minute it was quite insensible; in about half a minute more, the breathing became difficult, and the sounds of the heart less distinct. The breathing became gradually slower, and ceased altogether between three and four minutes after the respiration from the bladder commenced. The sounds of the heart were rather frequent, and scarcely audible, just before the breathing ceased, and they could not be heard afterwards. The chest was opened three-quarters of an hour after death: the lungs were of a pale-red colour, everywhere permeated with air, and a small quantity of fluid blood flowed from them on making an incision; the right cavities of the heart were quite full of blood, and the left cavities contained a small quantity.

“ Experiment 3.—A cat was made insensible in the same manner as the two previous ones. As it made strong efforts to get out of the jar, and consequently breathed more deeply, the chloroform took effect sooner; and it was removed and laid on the table, in a passive state, at the end of two minutes and a half. The respiration and sounds of the heart were quite natural. The

nose of the animal was placed in the mouth of a metal vessel, lined with bibulous paper, and used as a chloroform inhaler; the inhaler contained chloroform, and was surrounded with water of the temperature of 110° Fahr.; the stethoscope was kept applied to the chest whilst the chloroform was exhibited. After four or five inspirations from the inhaler, the heart suddenly ceased to beat, the breathing still going on; the inhaler was removed as soon as I was satisfied that the action of the heart had ceased, and there were two or three rather convulsive respirations afterwards, and then the breathing stopped; but, between one and two minutes later, there were two or three feeble inspirations, accompanied with motion of the nostrils, but no returning action of the heart could be heard. The chest was opened ten minutes after death: the lungs were quite pale throughout; there was a little clear serum in the pericardium; the heart appeared quite motionless when first observed, but, after exposure to the air for a short time, there were some slight contractions of a few fibres of the right ventricle; the right auricle and ventricle were filled with blood.

“ ‘The air in the inhaler which this cat breathed, probably contained between twenty and thirty per cent. of vapour of chloroform.’ ”

“ It is obvious that death from chloroform results from two causes, and assumes two forms: when the proportion of chloroform in the atmosphere breathed is limited to *from three to five per cent.* the fatal result *begins* with defective respiration, or *apnœa*, and proceeds

to asphyxia, and the Ready Method is the ready remedy; but when the proportion of chloroform amounts to *upwards of eight per cent*, death assumes at once the form of *asphyxia*, with either *simultaneous* or *subsequent* apnœa, and there is, it is to be feared, *no remedy*.

“This conclusion, which Dr. Snow drew from his admirable experiments, I drew independently from an attentive perusal of the accurate details of Mr. Paget’s interesting case.”

In looking over Dr. Snow’s other papers, I have been much amused, on reading a page in *The Lancet* of 1841-42, for October and November, pp. 133 and 212, to see the same war waged with the Royal Humane Society, in regard to the use of the *warm* bath in asphyxia, as is being again waged in the present day.

Dr. Snow showed, from the experiments of Edwards, that the warm bath must prove deleterious. Mr. Woolley contended then, as now, and with as little reason, and with the same discordance with physiological truth, that the warm bath *should* be used. Unfortunately, *the* remedy—the “Ready Method” was not then discovered; and as no method of *promptly* producing artificial respiration—the *sole life-giving process*—was then known, error has continued to prevail over truth. The warm bath is not only not remedial—it is positively destructive; as the merest tyro may know for himself, who will carefully repeat a few telling experiments.

One statement by Mr. Woolley is a little remarkable:

“he had not found artificial respiration of benefit *after* the warm bath failed to restore life” (p. 213): neither would he or any one else find respiration of benefit *after*, not the warm bath only, but “removal, the warm bath and galvanism,” had been tried in vain.

The lapse of fifteen years has not detracted from the accuracy and value of Dr. Snow's views.

We may now safely draw the following conclusions in the present state of science:

1. The warm bath in apnœa and asphyxia is a physiological and practical error.

In one case, at Boulogne, the patient having begun to breathe, was destroyed by being put into the warm bath.

2. In the absence of artificial respiration, the remedies are—free exposure of the surface to the breeze, and frictions of the limbs upwards, with pressure.

3. But the true remedy in apnœa is *Respiration*; and this is happily instantly accomplished by—the “Ready Method;” or, as I presume I must now call it—the MARSHALL HALL Method.

April, 1857.

Postural Respiration observed by Dr. Snow.

“*To the Editor of The Medical Times and Gazette.*

“Sir,—I shall be obliged if you will allow me to state that I believe Dr. Marshall Hall's method of artificial

respiration was quite efficient, as a method of artificial respiration in the case of death during the inhalation of amylene, which I related in the last number of the *Medical Times and Gazette*. That it was not efficient in restoring the patient is not to be wondered at, when his own natural respiration, continued for several minutes, had failed to restore the action of the heart. The artificial respiration was resorted to for want of any thing else which could afford a chance of benefit. I asked Mr. Fergusson's advice respecting the propriety of opening the jugular vein, with a view to relieve the probable distension of the right cavities of the heart; but as the veins of the neck were shrunk, and did not contain any blood, he did not think it would be of any use to open them. In Mr. Paget's recent case of death during the inhalation of chloroform, the patient continued to breathe after the pulse had ceased, and the artificial respiration was not effectual in restoring him.

“ When the failure of the pulse is the consequence of the absence of breathing, as in drowning, artificial respiration is the proper remedy; and I believe the method of Dr. Marshall Hall to be a very efficient one. I had, a few days ago, the opportunity of seeing its good effects on a child born in a state of partial asphyxia. The child presented by the shoulder, but was easily turned by Mr. Edward Tegar, while the mother was under the influence of chloroform. Being a large child, however, the circulation between it and the placenta was interrupted for a short time during the passage of the head,

and when born, although there was a slow pulsation in the funis, it breathed only by distant gasps; its muscles were completely relaxed, and it was so insensible, that dashing cold water on it had no effect on the respiration. The gasping was becoming less frequent, and the pulse was failing, when Mr. Tegart and I began Dr. Hall's method. I could hear the air entering the larynx at every turn of the child. Its own inspirations soon became more frequent; it became of a florid colour, in place of the livid one it had previously presented; its muscles began to be tense and active, and in a very short time it was crying vigorously.

“In any case of accident from chloroform, or any other narcotic vapour, if the respiration were suspended by the over-action of the medicine on the brain, and the heart were not entirely paralysed, artificial respiration would, I believe, restore the patient. Such is the result of my experiments on animals; but where the heart itself is the organ chiefly or solely affected, artificial respiration, although affording a chance of benefit, is likely to be of little avail; and these apparently are the cases of accident which have ended fatally, notwithstanding prompt assistance.

“I am, &c.

“JOHN SNOW, M.D.”

“18, Sackville Street, April, 1857.”

Postural Respiration observed by Dr. McCormac.

“ Belfast, September 20, 1856.

“ My dear Sir,—In my experiment as to the induction of postural respiration, I followed strictly your most valuable suggestions. The body was that of a vigorous man, not long dead. The right shoulder and side were made the axis of rotation. I inclined the body forward, in the prone position, as you direct, then raised it on the side and beyond to an angle of about 130° . I continued this alternating motion for some time; but I did not measure (I had no immediate facilities for doing so) the amount of inspiration and expiration produced. It was very satisfactory to me, however, to observe the gush of air, as it entered and left the nostrils, where the transit was more obvious than by the mouth.

“ I had often witnessed the bubbling transit of air thus, during the movements to which the remains of the dead are necessarily subjected, but was far from drawing from it the important practical inference which you have done.

“ I shall try your method of postural respiration at the earliest opportunity, not only in the case of the drowned, *but in other cases of asphyxiated persons*—persons asphyxiated from or by *irrespirable or poisonous gases*, the undue *inhalation of chloroform*, and by *strong drink*; in all of which, your method, I conceive, is

calculated, presumably, to realise the most beneficial results.

“ Permit me, my dear Sir, to subscribe myself yours most faithfully,

“ HENRY McCORMAC.”

“ Dr. Marshall Hall.”

*Case of Narcotic Poisoning, in a child thirteen months old;
by Charles Blades, Esq. of Tattershall.*

The following case is full of the most thrilling interest. Its simple details and the perseverance with which the treatment was pursued are admirable :

“ *To the Editor of The Lancet.*

“ Permit me, through your journal, to record the following case of narcotism, illustrating as it does Dr. Marshall Hall’s Ready Method in cases of poisoning.

“ On the 11th ultimo, at two P. M. I was called to see a child, aged thirteen months, which had had poppy-water given to it the previous evening. I found it in a state of perfect unconsciousness ; there was no respiration ; no pulse could be detected. I immediately adopted the Ready Method, persevering in it *for several hours!* and was well rewarded for my trouble, by first detecting, through the fontanel, a slight motion of the brain, then

around the umbilicus, and ultimately by the child's complete recovery.

“ The successful result of this case is due to Dr. Marshall Hall's plain and practical instructions in postural respiration, published in your valuable journal.

“ I am, Sir, your obedient servant,

“ CHARLES BLADES.”

“ Tattershall, Feb. 1857.”

“ Tattershall, Feb. 28th, 1857.

“ Dear Sir,—I have much pleasure in complying with your request for further details of my case of poisoning.

“ On making inquiries of the relatives of my little patient, I learnt that it had been for the last few days suffering from a cough, and that they had given it a sufficient quantity of poppy-water to compose it to sleep. It slept all night and the following morning without intermission, when, about twelve o'clock A. M. on attempting to give it some broth, it was seized with a fit, to relieve which it was placed in a *warm bath*, but was soon removed from thence, apparently lifeless.

“ On my arrival at the house, a little *before two o'clock* P. M. I found the child lying in its grandmother's arms, in a state of insensibility; the eyes were closed, the pupils contracted; no pulse and no respiration could be detected.

“ I immediately placed it in the prone position, with one hand under its forehead, the other under the chest. I commenced turning the body on the side and a little

beyond, and then on the face, alternately, repeating these measures thirteen or fourteen times in a minute; at the same time, the attendants were desired to rub the limbs upwards simultaneously.

“ I had not continued my attempts at resuscitation more than a few minutes, when a slight motion of the brain became perceptible, and gasping movements of the mouth followed.

“ Although no decided amendment displayed itself for some time, yet I was fully convinced that the efficient maintenance of the respiratory process was of the first importance, not only to the continuance of the circulation, but also as being the chief means by which the poison is eliminated. I therefore persevered in the postural movements until *half-past six* the same evening, before I could pronounce my patient out of danger.

“ Apologizing for not replying to your note earlier, I remain your obedient servant,

“ CHARLES BLADES.”

“ Dr. Marshall Hall.”

POSTSCRIPT TO THE CASES.

§ I.—*Two Cases by Dr. Lawrence, of Carmarthen.*

I cannot refrain from inserting the two following cases from the pen of Dr. Lawrence, of Carmarthen, although they were not treated by postural respiration. Each contains an idea of deep interest.

The *object* of the suction in the first case was obviously that of the prone position—"to clear the throat;" how far less effectual for that object I need scarcely point out. In the supine position, part of the fluids of the throat, though drawn out of their first position, would be apt to *flow back* again when the act of suction ceased; indeed, the subsequent *inspiration* might *draw* it into the larynx.

It is singular enough that it is the very opposite to the "mouth to mouth" insufflation recommended in some cases of apnœa, as in that of the still-born infant.

The late Mr. Reid devised a syringe with a double action, thinking to draw out and force in the air alternately.

To be effectual, both of these objects should indeed be combined, together with the further precaution of entirely removing the danger of the fluids again falling back, or being drawn back, into the larynx. Now *all* these objects *are* admirably *combined* in *prone* and *postural* respiration alone.

The second case illustrates the subject of laryngismus and its apnœa, and shows the value of mere pressure made on the chest, of the efficiency and safety of which, when '*the throat is clear*,' no one can doubt; however otherwise full of danger.

But I proceed to give the interesting cases themselves:

"Seventeen or eighteen years since, Dr. G. a surgeon of Tenby, was bathing in the sea, and had a stick in his mouth, decoying a young Newfoundland dog into the

water. After being some time in the sea, he was observed, by a mason on the top of a house in the town, and by a gentleman on the Castle Hill (looking out by St. Catherine's Rock, where there is a strong current at the return of the sea), with the stick under his chin. It had fallen from his mouth and kept him above water. (A young clergyman was carried off and drowned at this spot a few years ago.) The mason ran down, gave the alarm, and brought him out quite lifeless. He was taken to the Bath Rooms, and I was early in attendance. I immediately began friction, warm applications, plenty of fresh air by keeping all persons at a distance but my assistants. I pressed on the chest, sides, &c. to exhaust and inflate the lungs, and followed out a treatment the same as Dr. M. Hall recommends, with two exceptions, which I think are very *important* ones, and such as I shall bear in mind at any future period: that of turning on the face, and *not* using the warm bath *too early*. I did place my patient in a warm bath as soon as he began to respire, in the case of Mr. G.

“ I offered half a sovereign to any person who would suck at his nose or mouth. A man came forward and did it. Mr. G. soon afterwards drew one inspiration; the man of course spat out much fluid which he drew from the lungs. The gentleman from the Castle Hill, an agent to the late Lord Milford, seeing the effect, paid the man the half-sovereign !

“ This treatment was suggested to me by two cases which I read in the papers many years ago, one of which

I cut out, and I enclose to you*; in the other, after failure of the medical man, a chimney-sweeper's boy came forward and said "he would restore the patient." He began the suction, and the patient recovered!"

"The second case was one of asphyxia in a child of my own. He was attacked with whooping-cough, the severest case I think I ever saw, at two or three months old. In a fit of coughing, the spasm was so severe and of so long duration, that breathing ceased. His face gradually became blue, his jaw and hands fell, and death appeared to have taken place. A medical friend, who was attending my child with me, left my house; some little time elapsed, when I roused myself, ordered a warm bath, and began frictions and alternate pressure on the sides, chest, &c. &c. to inflate and exhaust the lungs;

* "*Extraordinary Mode of Resuscitation.*" — A youth, named Henry Rice, having fallen into the basin, City Road, a quarter of an hour elapsed before he could be got out. The boy was conveyed to the Wenlock Arms, and two surgeons immediately attended, who, after an hour's exertion, were unsuccessful in their attempts to restore the youth to life. A drunken man in the tap-room, waking from his sleep and learning that the medical men had failed in their attempts, staggered into the room and said he would restore the boy; and applying his mouth to that of the youth (at the same time including the nostrils), by strong suction, as if drawing the breath from the patient, actually renovated the lad in a few minutes, to the astonishment of all present. This was the ninth person whom this individual had restored to life in a similar manner. This extraordinary case has excited much speculation and has led to the conjecture that an instrument might be made to answer the means adopted in these instances of resuscitation, which would be highly beneficial in every point of view."

and in about ten minutes the child took one inspiration, and then gradually recovered. It was most pleasing to see the gradual blue cloud of the face pass off, and the natural colour return. My medical friend had expected my child was dead; and when I requested him to call the next day, he did not believe it was to see the child, or that the child could be restored. He witnessed one or two similar attacks, and my successful efforts at recovery. I changed the air as early as possible, an immediate improvement took place, and my child recovered, and is now alive."

§ II.—*On obsolete Modes of Treatment.*

Amongst the obsolete modes of treatment pointed out by the Royal Humane Society, one deserves especial notice and consideration :

" Do not roll the body on casks."

There is in this obsolete rule an error and a truth, equally unknown to those who first proposed it. Their idea was that water had been imbibed into the *lungs* or into the *stomach*, and the manœuvre proposed was intended to allow of its flowing away. This is the error. Had the idea been fixed upon the condition of the *pharynx* and *larynx*, obstructed, not with water merely, but with mucus and fluids regurgitated from the stomach, it would have been just and true, and the *prone* position of the patient, when placed on the cask, would have been

the true and just means of removing those fluids, and of “*clearing the Throat!*”

But the patient was “rolled” on the cask; that is, I suppose, being placed in a position perpendicular to the axis of that vessel, he was *moved* so as to augment and diminish the pressure of his body on the thorax and abdomen, alternately. But this is precisely the effect of ‘pronation and rotation!’

The only observations which this paragraph calls forth, are—first, that the idea of getting rid of water is founded in error; secondly, that the result of the postural changes was *not* — *postural Respiration*. It remains as a medical fallacy and curiosity—a specimen of what passes for ‘experience.’

The idea of disgorging water supposed to have been imbibed into the lungs and stomach, prevailed in the profession. I have been shown the following paragraph by Smollett, who, it must be borne in mind, was a physician:

“In crossing the river, my ’squire and his horse were swept away by the stream; and, with some difficulty, I have been able to drag him ashore, though I am afraid my assistance reached him too late; for since I brought him to land, he has given no signs of life.

“Here he was interrupted by a groan, which issued from the chest of the ’squire, and terrified the spectators as much as it comforted the master. After some recollection, Mr. Fillet began to undress the body, which was laid in a blanket on the floor, and rolled from side to side by his direction.

“ *A considerable quantity of water being discharged from the mouth of this unfortunate 'squire, he uttered a hideous roar, and opening his eyes, stared wildly around; then the surgeon undertook for his recovery.*” *

No one will imagine that the true effect of this procedure was *suspected* even, by its authors.

I cannot doubt that the two truths unconsciously hidden under these propositions saved many lives. They were, in fact, clumsy, unsuspected modes of ‘clearing the Throat,’ and of ‘imitating Respiration’—in a word, of ‘prone and postural respiration,’ whilst intending to remove water from the bronchia and stomach, which never existed there!

But, at least, this measure, clumsy and erroneous as it was, was preferable to the ‘warm bath’ by which it was superseded.

When recently at Folkestone, and enquiring about the treatment of the drowned, one boatman said *his* mode was to *roll* the patient over and over on the ground. Respiration would doubtless be the unlooked-for result of such a manœuvre.

But the real object of these proceedings was, like that of suspending the patient by the *feet*, to empty the lungs and stomach of *water*! Good might, in some cases, come out of this ignorance.

In conclusion, I may observe—

1. That *suction* would, in general, be followed by

* Smollett's *Launcelot Greaves*, chap. ii.

little result, since the frothy mucus drawn into the mouth during this operation would be probably drawn back by the succeeding *inspiration*, the subject being in the *supine* position.

2. All attempts at respiration, whether by *forcing* or by *suction*, would be attended with the choking of the air-passages by the fluids in the pharynx, the *supine* position being equally observed.

More than these few observations, the subject of obsolete modes of treatment of the drowned scarcely deserves, so entirely practical is the design of this little volume.

I trust I may at length *add* to the list, the warm bath, the most fatal of all, by the loss of precious time, and of the sole real remedy, which it entails, not to repeat the positively injurious tendency of this mistaken remedy.

I conclude that—

1. In all former postural measures—as holding the patient up by the feet, the rolling on a cask, &c.—the idea and the motive were to empty the lungs and the stomach of water imbibed during the period of submersion.

I need not say that the whole proceeding was an error.

2. That by accident *respiration* might thus be produced, with its happy results.

3. That *all* attempts at artificial respiration in the *supine* position could only be successful by a similar happy accident—the *throat* chancing to be *free*.

4. That mouth to mouth *suction* or *forcing* might be successful; but might also be ineffectual in one case, and *fatal* in another.

In a word, nothing is *certain*, nothing is *safe*, except in the PRONE position.

The warm bath least of all.

PART THIRD.

The Regius Professor of Medicine, Dr. Ogle, of Trinity College, Oxford, has issued an address to the members of Convocation, in which he states—"The Vice-Chancellor of the University having ruled that no one may read an address in Convocation, and my health preventing the more obvious alternative which presents itself, I am constrained to make known by this mode of communication the views which I entertain respecting the statute, De Professore Anatomie et Aldrichiáno, and which I deem it my duty to put forth :

"I UNHESITATINGLY, ex cathedrâ, ASSERT, THAT TO SEVER THE STUDIES OF ANATOMY AND PHYSIOLOGY FROM THAT OF MEDICINE, IS VIRTUALLY TO REDUCE THE LATTER SCIENCE TO A MERE EMPIRICISM."

§ I.—*Edwards de l'Influence des Agens Physiques sur la Vie.*

EVERY one who presumes to give an opinion on the subject of apnœa or asphyxia, must begin by a profound study of this incomparable work ; a work to which the discerning author devoted six years, experimenting on every tribe of animal, at all seasons of the year.

There are three distinct chapters on apnœa. There are the same number on the influence of temperature in apnœa.

The general conclusions are these :—

1. The *higher* the temperature, within physiological limits, the *sooner* the animal *perishes* if deprived of air.

2. The *lower* the temperature, also within physiological limits, the *longer* the animal *survives* the privation of air.

That is the physiological limit of temperature, beyond which, *positive* destructive effects are observed.

Every means, therefore, of raising the temperature of the patient afflicted with apnœa, and not breathing, as the continuous warm bath, and the several others recommended by the Royal Humane Society, are deleterious. Whilst every means of maintaining a cool temperature, and especially the free exposure of the face, chest, and surface generally, to the mild, cool breeze, is beneficial.

These are the important conclusions to which *comparative experiment* has led the physiologist. It is opposed to the fallacious "experience" of those, the objects of whose observations never can be comparative, so complicated is the question of apnœa, and so various the condition of the patient.

Nothing can be more glaring than the one glaring fallacy of substituting *warmth* for AIR, when the patient is dying for want of AIR !

The truth is, the propriety of the warm bath in apnœa is a vulgar error ; an error which physiology in the volume of Edwards ought long ago to have corrected.

Who will pretend, after this, that medicine is not physiological, and fail to agree with the opinion recently expressed by Dr. Ogle, the Regius Professor of Medicine, of Trinity College, Oxford ?

"The Vice-Chancellor of the University having ruled that no one may read an address in Convocation, and my health preventing the more obvious alternative which presents itself, I am constrained to make known by this mode of communication the views which I entertain respecting the statute, De Professore Anatomix et Aldrichiâno, and which I deem it my duty to put forth. I unhesitatingly, *ex cathedrâ*, assert, that to sever the studies of anatomy and physiology from that of medicine, is virtually to reduce the latter science to a mere empiricism."

An opinion which I have long advocated. Yet little minds still speak of "theory" as inferior to what they term "experience."

Above all things, let us be frank, candid, just.

To revert to Edwards' work: warmth, previous to the privation of air, is deleterious; cold, beneficial. Animals die sooner of apnœa in summer than in winter.

There is still another interesting fact, which bears upon the same subject:

Some very young animals, as the rabbit, the dog, the cat, which are born feeble, and with the eyes closed, soon lose their temperature, if separated from their mother and placed singly; others, as the guinea pig, born less helpless, and with the eyes open, placed in similar circumstances, sustain their own temperature. The former sustain comparatively a long privation of air, submerged in water of the same temperature, even to half an hour; the latter soon perish, scarcely surviving the privation of air three or four minutes.

Animals perish from apnœa the more speedily, the greater their relation to *heat*, whatever that relation may be, external or internal.

Every ray of light on this subject converges to the same focus.

§ II.—*Relation between the Dynamics and Stimuli in the Animal Economy.*

THE dynamics in the animal economy are two: that seated in the spinal system; and that seated in the muscular system. The former is *excitor*; the latter, the *excitability*--the irritability of Haller.

The stimuli of the animal economy are also, principally, two : *air* and *food*.

Life consists in a series of actions and re-actions of these several agents and re-agents ; the dynamics and the stimuli bear an inverse ratio to each other : in the cases in which the dynamics are low in degree, the stimuli are uniformly high ; and in the case in which the dynamics are high, the stimuli are low. Out of the varied condition of these, relative and absolute, the varied forms and conditions of animated beings take their origin.

Take an animal of high respiration, as the bird : the stimuli, air and food, are extremely high, the dynamics proportionately low. Choose, on the other hand, an animal said to be of cold blood : its respiration and the quantity of its food are extremely low, the dynamics high.

The dynamics in nerve and muscle, and the quantities of air and food, are inversely proportionate to each other, respectively.

The temperature is proportionate to the stimuli, air and food, and inversely proportionate to the dynamics.

The whole animal kingdom is subject to this *law*. It is the *Law of Life*.

In the human subject, activity, which is a condition of augmented stimuli, is attended by exhausted dynamics. Repose, and especially sleep, have the contrary effect.

The embryo may be compared to the reptile in regard to the dynamics and stimuli.

The application of these principles to the subject of

this volume is direct : the animal bears the privation of stimuli, air and food, in the inverse proportion to the quantity of stimuli : the bird perishes from apnœa, or from the want of food, sooner than the animal lower in the scale ; the infant that has breathed, sooner than the new-born infant.

The animal reduced in temperature bears the privation of air and food better than the animal warmed by clothing and exercise.

In the concluding part of this volume, I propose to return still more particularly to the interesting subject of *the Law of Life*.

§ III.—*The Nature of Life.*

Life is a slow combustion. In all circumstances, materials which are capable of union with oxygen, and this gas, are brought into contact and union throughout the duration of the vital processes. The want of food (the fuel) and the want of oxygen (the supporter of combustion) are equally the cause of the extinction of this chemical vital process, whether it exist in the form of flame, spark, or combustion in a still lower form.

Without fuel, or, still more to our present purpose, *without* the supporter of combustion (oxygen), how can mere external heat be efficient in producing the life-constituting process ? The essential point is to bring the combustible into due contact with the supporter of combustion ; this accomplished, external temperature may accelerate a process which it cannot, *per se*, imitate or endure.

These facts must never be overlooked by the physician who is called to treat a case of failing vital combustion: gently to fan the smouldering embers into the real process of combustion, which is *Life*, is *our ONLY hope*; I say, “gently to fan,” for too much respiration soon may *cool* the doubtful embers, and extinguish life!

Who would dream of resuscitating dying embers by *warmth*? Surely either *food* or *air* is the restorative. And let it be remembered that the two things are not *analogical* merely, but *identical*—for *Life* is a *slow combustion*. In apnœa, therefore, in which, *not fuel*, but *air*, is wanted, let us *FAN* into flame the “vital spark.”

It has long been a question with me, whether *slow* combustion is in every case ascertained in pure oxygen gas, and whether it is especially in the case of respiration? a question to which I have already attended, and which I propose to submit to the only true test of comparative experiment.

The discovery that life is a true combustion has been traced, in modern times, by Lavoisier and by Liebig. It constitutes a great epoch in physiology.

A few days only before his most cruel death, Lavoisier wrote these memorable words:

“Ou peut donc dire avec les anciens que le flambeau de la vie s’allume au moment où l’enfant respire pour la première fois, et qu’il ne s’éteint qu’à la mort.”

The spark, if not the flame of life, begins in utero, sustained by the placental nutrition and respiration, food and air.

§ IV.—*On the Condition of the Circulation in Apnœa.*

What signs have we in cases of apnœa of a little remaining pulsation of the heart and of circulation? We are, in general, too much engaged with the *treatment* of the patient to *observe* the symptoms with accuracy. The best plan would be to let the treatment devolve on one person, and observation on another, when the circumstances permit.

1. The first object to examine is the *eye*, especially the *cornea* ;

2. The second involves the lips and the face, the nails and the hands ;

3. The third, the condition of the arteries and veins, especially the pulse and the brachial veins, the carotids and the jugulars ;

4. The fourth is the heart itself, carefully applying the ear during a pause between the respirations ;

5. In hopeless cases, an incision may be made into the integument, to see if blood will flow ; choosing some part which still retains its warmth.

We should watch for lividity, for flaccidity, and endeavour to discover whether, the hand and arm being put into hot water, a brachial vein will tumefy if under the influence of a ligature applied round the arm.

We should watch for *effects* of our efforts to produce postural respiration, especially in change of colour in the lip and face.

Whatever intimation of a persistence of circulation may be obtained from these sources, we know that, so long as gasping or convulsive movement may continue, we have evidence of a morbid condition or change in the blood, in the vessels, or in the tissues of the medulla oblongata or medulla spinalis.

In experiments, in the midst of all these observations the carotid may be laid bare, as was done by Legallois, and the degrees of repletion and colour may be fully observed : they present the criterion of the power of the heart to propel blood.*

There is another source of knowledge in regard to the persistence of the circulation, in that of the temperature. But observations are wanting on this point. The axilla and the rectum might be made the subject of this inquiry.

Any indication of remaining circulation should stimulate us to steady perseverance in the postural respiration. If the recorded facts of long-sustained apnœa are incredible, those of the effects of perseverance in recent efforts to restore the patient are not less so.

I here terminate this little work. If spared, I propose to resume it hereafter. Meantime I cannot resist the temptation of introducing a Lecture given four years ago at the request of the authorities of the Smithsonian Institute at Washington. The physiologist will perceive its strict bearing on the vital question of Apnœa.

* "Sur le Principe de la Vie."—1812. p. 71.

ZOONOMIA;
OR
THE LAW OF ANIMAL LIFE;

A LECTURE,

DELIVERED AT THE SMITHSONIAN INSTITUTE, WASHINGTON, D.C. U.S.

ON MARCH 8, 1853.

GENTLEMEN,

I congratulate myself on the opportunity afforded me, by your kind invitation, to unfold a principle in physiology on which I have long meditated and experimented, and which I have ventured to designate The Law of Animal Life.

Many have been the attempts to define *life*. All have, I think, proved abortive. I shall not, in my turn, venture to attempt that in which so many have failed. My object will be rather to describe than to define.

Life, then, may be justly viewed as consisting in a comprehensive system of action and re-action; of the action of certain physical and chemical influences, and the re-action of certain vital powers in organized beings.

Throughout the animal, and indeed the vegetable, kingdoms, the *primary* organic agents and re-agents are *pollen* and *ova*. Life first consists in the reciprocal action of these upon each other. Such is the very type and essence of life in its earliest dawn. Harvey said, *Omne vivum ab ovo*. He might, with equal truth, have said, *Omne vivum a polline*; and, with still greater truth, *Omne vivum a polline, et ovo*.

Each of them—the pollen, the ovum—was originally a *creation*. Their mutual and reciprocal action is a phenomenon which the Creator has impressed on this portion of His works as the *fiat* of His will.

That this action *is* perfectly reciprocal is proved by the resemblance of the new being or offspring—be it animal or vegetable—to *both* parents. The event is at present as inscrutable in its nature and essence, as it is interesting to the physiologist and philosopher as a subject of observation and new inquiry.

Why *this* seed of the *Triticum Indicum*, or Indian corn, on which pollen has fallen, should, if planted in soil, and exposed to the genial influences of heat and moisture, become a noble and useful plant; and why this other, to which, from its mode of growth and treatment, no pollen has been allowed to have access, shall, under similar circumstances and influences, undergo decay and decomposition, who can tell? Why *this* egg, which has been fertilized by pollen, should, under similar genial influences, become a bird, and eventually soar into the regions of the atmosphere; and why this other, unaffected by pollen, should pass into a state of putrefaction, who can declare? Who will attempt to explain why those “*divinæ particulæ auræ*,” which exist in the form of pollen, can alone vivify these ova? Who can say *what* there is in these ova, and *what* there is in the appropriate pollen—for the *two* are *equally* essential—which develop growth, and form, and *life*?

Look at these ova and at these seeds. On *this* ovum, and on *this* seed, no pollen has ever been shed. They will, though placed in circumstances the most favourable for development, only pass the more readily into decay. But this other ovum, this other seed, on which pollen,

life-giving pollen, has shed itself, will, under similar circumstances, germinate and pass into life, the whole subsequent being becoming expressly imbued with the equally inscrutable properties of the pollen, and of the ovum or seed.

What is the condition of this pollenized, this fructified ovum or seed, *before* active life begins? Is life in abeyance? Or is it in actual existence, only in its lowest and imperceptible form? Have eggs and seed a temperature of their own, above that of the medium in which they are placed? And what is the condition of this *offset* of an animal or animalcule (as the planaria), or of this plant? Both will continue to live independently of the original stem. Both may be multiplied and propagated by new and similar offsets. Both are, as I have stated, equally imbued with the properties of both the original pollen and ovum. All this is mysterious, inscrutable in its essence, constituting one of the arcana of organic nature, which may long, may for ever, be hidden from us.

But the *laws* of life, and those of the material and inorganic world may be detected; and their detection and investigation are amongst the most legitimate, interesting, and important objects of philosophical inquiry. At present, I beg only to state, that whilst pollen places the ovum or seed under *vital* influences, its absence allows them to become the prey of mere physical or chemical agencies alone.

The further essential and distinctive characteristic of organized beings, that in which they differ from the

objects of the inorganic world, is—*membrane*. Through this membrane, a special function of transition takes place, constituting endosmosis and exosmosis, or imbibition and exudation.

If this membrane be injured or broken down, the materials of organized being are again immediately subtracted from the laws of organization, and delivered over to the ordinary principles of chemical action—decay or *eremacausis*—from which that membrane had preserved them whilst it placed them under the dominion or modification of vital influences. Examples of this fact are afforded by bruises of animal or vegetable tissues, which, if slight, are repaired by the vital powers ; but if severe, lead to death or decay. How extraordinary are the changes which almost immediately take place in bruised flesh, or in a bruised orange or apple !

But I must hasten from these preliminary views, and pass on to the more express subject of this lecture. All living being, from the serpent to the eagle, possess in common, peculiar *dynamic* properties ; in all, these properties respond to appropriate external and internal *stimuli*. On the reciprocal play, action, and re-action, of these forces and agents, life, with all its varied phenomena, in all its varied forms, essentially depends.

These dynamics and these stimuli bear a relative proportion to each other. This proportion is *inverse* ; the higher the dynamic, the lower the stimuli, and *vice versâ*. *Such is—the Law of Animal Life.*

In the animal kingdom, *two* forms of dynamics exist.

The first has its seat in the nervous system, or, more definitely, in the spinal and ganglionic sub-systems : I venture to designate it by the term *neuro-dynamic*. The second has its seat in the muscular system ; it may be designated *myo-dynamic*. The stimuli exist in greater numbers, for they consist in physical and chemical agents of the external world, such as air, food, water, heat, light, the galvanic influence, &c.

I must introduce the subject of the vital dynamics by showing those who are not familiar with physiology an experiment full of the deepest interest. I place before you a frog, prepared for the purpose ; and you will observe how the most elevated principles of philosophy may be illustrated by what you may deem the humblest objects of creation. The physiologist knows and feels that his science, elevated as it is, is included in the most insignificant insect that lives—the caterpillar or the butterfly.

The nervous system consists in *three* sub-systems ; the first is that of which the brain, or cerebrum, is the centre, and sensation and volition the special functions. I have removed this centre and these functions from this frog by removing the head, and with it, the very centre of the system, or sub-system, itself ; the creature is thus entirely deprived of sensibility ; the idea of suffering is excluded. It is also deprived of volition ; all *spontaneous* movements are impossible.

Yet there *is* a source and power of movement remaining ; for you observe the effect of irritation of the integu-

ment covering the toe or foot. This power resides in the spinal marrow, or spinal centre, and certain nerves proceeding *to it* and *from it*, termed therefore eisodic or in-going, and exodic or out-going. I have designated this power neuro-dynamic ; it was formerly termed the *vis nervosa* ; its English appellation would be *nerve-power*.

The nerves which proceed *to* the centre of this spinal system *arise* from the skin. I have removed the skin from the left foot, and you will observe that the same irritation which, applied to the right foot, induced contraction of the muscles, is inoperative when applied to this denuded limb ; in effect, the *origin* of the eisodic nerve has been removed with the integument.

But I now irritate the spinal centre itself ; you observe the convulsions produced.

Lastly, I irritate these, the lumbar nerves ; they are exodic, and proceed to the muscles ; again the limbs are violently agitated by movements.

Here, then, are phenomena arising out of irritation of the nerves, eisodic and exodic, and the centre of the spinal system. They attest the neuro-dynamic power of those several nervous tissues.

But there is still a third sub-system of the nervous system ; it is termed the ganglionic, and it is connected with all that is *interior* or *within* us. I have here placed aside the viscera of the frog, and with them the ganglionic sub-system belonging to them—the heart, the stomach, the intestines, &c. If you were nearer you would see the

heart pulsate, and the stomach and intestines move by what is termed peristaltic action. These phenomena are effected through the medium of the ganglionic portion of the nervous system in which the neuro-dynamic must also reside.

But, besides the power residing in the nervous tissues, there is, as above stated, another dynamic. Its seat is the *muscular* tissue, for which reason it may be designated the *myo-dynamic*. You observe the effect of a very slight galvanic influence passed along this muscle; the muscle is immediately vigorously contracted. This is the *vis muscularis* of physiologists, the *muscle-power*.

These vital dynamics, and the physical and chemical stimuli to which I have alluded, bear an inverse ratio to each other. This is the case both primarily and secondarily—the first by creation; the second, by a natural operation and *effect*; for if stimulus be diminished, the dynamic becomes augmented; and if the stimulus be augmented, the dynamic becomes exhausted, and, in some degree, proportionately reduced, as natural events, causes and effects.

Thus the effect of hibernation, during which the stimuli of air, food, temperature, and nutrition are reduced to their minimum, is to lead to augmented dynamic and excitability, and to what may very appropriately be designated *vernation*, or the activity of spring; whilst the effect of the augmented stimulus in the summer months, that is, of augmented air, food, temperature, and nutrition, is to exhaust or lessen the dynamic

of nervous and muscular fibre, however they may augment general activity and power of mass, and prepare the way for the next winter sleep.

By creation and the operation of natural causes, then, the *inverse ratio*, between dynamics and stimulus, in animated creation, is—*the Law of Life*.

The attempt to invert this law in either direction, and *equally* in either direction, is to destroy life. Unduly to augment the stimulus when the dynamic is high, or unduly to diminish the stimulus when the dynamic is low, is equally to interrupt the vital actions.

I will again illustrate my subject by a reference to the interesting case of hibernation :—If you take a bat from its winter quarters, from its state of hibernation, in which its respiration is at the minimum and its dynamic at the maximum, and make it fly about, and so augment the vital stimulus of respiration, it infallibly *dies* ! If, on the other hand, you take the same creature in its condition of summer activity, and of high respiration and low dynamic, and deprive it of air by immersion in water, or in an irrespirable gas, it dies too. Invert in either way the inverse ratio of dynamic and stimulus, and the result is fatal.

Low dynamic *requires* high stimulus ; high dynamic, low stimulus. The higher the dynamic, the more capable is the animal of the further abstraction of stimulus, and *vice versâ*. If, instead of taking a bat from its summer activity, you take it in its state of hibernation, and now immerse it in water for ten minutes or even longer, it is

altogether uninjured. The bat, taken in its state of activity, and submerged in water, dies in two minutes and a half.

Thus, the hibernating animal dies if its respiration be augmented, whilst it can bear its suspension; the same animal, in its state of vernal activity, can bear its respiration to be augmented, but dies speedily if it be suspended!

I will illustrate this view by another order of facts: The tadpole of the frog breathes in water, and feeds on water-plants; the same tadpole, become a frog, breathes in atmospheric air, and feeds on insects. It has become a higher breather—a higher feeder. In the former state, the dynamic, in the latter the stimulus, is comparatively greater. The tadpole would die if taken out of its element, the water; the young frog would drown if compelled to remain in it!

These facts are the results of innumerable experiments. I shall take occasion to revert to them hereafter.

Besides being *inverse*, to which there is no exception, the *ratio* between dynamic and stimulus may be higher or lower. It is in this manner that we are enabled to explain the *modes* of life. As life in general is a result of stimulus *into* dynamics, we should, without a provision of this kind, see all animals *equally* active or inactive. Either the reptile would not creep slowly, or the bird tribe would not soar into the atmosphere. But we observe, in fact, that when the stimulus is *disproportionately* low, the animal is of low activity; and that

when it is *disproportionately* high, the animal is in the enjoyment of an intense degree of activity.

Throughout animated nature, as I have already stated, in all the varied forms and modes of life, from the eagle to the serpent, the dynamic and the stimuli are in an inverse ratio to each other. Such, as I have observed and often repeated, is the Law of Life. In the bird tribes, the quantity of air and food imbibed is extreme, the degree of dynamic very low; in the reptile tribes, the quantity of stimulus is low, and the degree of dynamic high.

The following formulæ may serve to express this general fact:

Stimulus ... 8 ... 4 ... 2 ... 1

Dynamic ... 1 ... 2 ... 4 ... 8

The degree of activity, or of inactivity, in all these cases may be supposed to remain the same; but to explain the greater activity of the bird, and the inactivity of the reptile, a modification of the formulæ is required, which may be thus expressed:—

Stimulus ... 1 ... 2+2 ... 4+8 ... 8+24

Dynamic ... 8 ... 4 ... 2 ... 1

In this manner, whilst the inverse ratio between the stimulus and the dynamic, generally speaking, remains, that of the former may *augment* more rapidly, as we pass into the more active forms of living beings, than that of the latter *diminishes*; and thus the bird and the insect fly, whilst the reptile and caterpillar creep. With higher stimulus, the animal becomes more bird-like; with lower stimulus, it becomes more reptile.

With augmented air and food, other organs, besides those of respiration and digestion, become stimulated to greater action. There is especially a correlation between the rapidity of the action of the heart and of the acts of respiration, arising in a peculiar and reciprocal manner out of the play of stimulus and of the neuro-dynamic, which resides in the spinal and ganglionic sub-systems and the myo-dynamic in the muscles which are respectively under their dominion, and out of the law which binds them together, which deserves to be distinctly described. The blood flowing through the lungs exhales carbonic acid ; this is the internal excitor of inspiration, acting on the fine branches of the pneumogastric nerves spread over the lining membrane of the lungs ; the more rapid the circulation, the greater the quantity of carbonic acid exhaled, and consequently the more rapid the respiration. But this respiration brings the oxygen of the atmosphere into contact with the pneumonic blood in its turn, through the same pulmonary membrane ; this oxygen is absorbed by the blood, passes into the circulation, and stimulates the heart to augmented action, and augments the rapidity of the circulation. This last induces, in its turn, a greater exhalation of carbonic acid in the lungs, again augmenting respiration, &c. In proportion to the augmented stimulus, the dynamic is diminished.

The *changes* which take place in regard to the ratio of dynamic and stimulus are of *two* kinds:—1, *Structural* ; 2, *Physiological*. The former, in metamorphosis, is usually, if not always, upwards, to a state of higher

activity,—and to a state of higher stimulus with diminished dynamic ; the latter takes place in both directions, being to one of higher stimulus in vernalization, and to one of higher dynamic in hibernation. Activity on the one hand, and repose, and especially sleep, on the other, *induce* similar, though less-marked, effects.

I think I have said enough to convince you, gentlemen, that there is, in this Law of Life, a most interesting and important fact—a vast generalization. This generalization embraces *three* great objects—1, The scale of animated being ; 2, The metamorphosis, and, perhaps, mere development ; 3, Physiological changes. I know of no law so general, so expansive.

I may now observe that it is of deep interest to trace the *criteria* of the ratio between dynamic and stimulus.

1. Galvanism is a test of neuro- and myo-dynamic, just as nerve and muscle in the animal in which these dynamics are high—as the frog—become galvanoscopic, or a test of galvanism.

2. In the animal in which the stimulus is high, the temperature and its measurer, the thermometer, become a test of its degree, and of course of the inverse condition of the dynamic.

3. The degree of activity, or of inactivity, denotes the relative condition of the two elements of the Law of Life.

4. It has already been noticed, that, in proportion to the dynamic, and in the inverse proportion to the stimulus, the animal possesses the power of bearing the subtraction

of stimulus, the privation of air and of food, and is, in more senses than one, endowed with *tenacity of life*.

The length of time during which an animal can bear the privation of air, or breathe a given limited quantity of air, is proportionate to the dynamic.

5. The quantity of respiration affords a measure of the stimulus. This is ascertained in various ways—1, By the structure and extent of the *lungs*; 2, By the number of the respirations; 3, By the quantity of oxygen imbibed, and of carbonic acid exhaled.

In proportion to the *surface* of the lungs on which the methæmatus or blood-changing channels are spread, in proportion therefore to the complexity of the structure of the lungs is the quantity of respiration. The fish has a mere gill; the batrachian has a vesicular lung, with or without subdivisions or intersections, as we observe in the triton, or in the frog or toad respectively; the lung of the serpent, the tortoise, the tribes of the mammalia, and of the birds, becomes more and more complex and extended; in the insect and in the bird, the respiration is extended over the system, not being limited to one organ; in the insect, indeed, each articulate segment is furnished with an analogue of the medulla oblongata, as a central nervous organ of the respiration. The dynamic exists in an inverse proportion.

6. The quantity of food assimilated or respired is a stimulus in itself, and, in its proportion to respiration, becomes a measure and criterion of the degree of dynamic inversely. In speaking of the quantity of stimulus, as

represented by the food, we must also bear in mind the quality as well as the quantity of that food, and its convertibility into calorifacient and nutrient principles. *Insect* food is, perhaps, of all kinds of food, the most stimulant, whilst vegetable food is the least so. It must also be a question how much of the food is really made available, and how much is excreted, unrespired, unasimilated.

7. We have in the circulation a criterion of the kind and character of life ; slow and with few methæmatus vessels in the animal of low stimulus and high dynamic, it becomes quicker with more crowded vessels as the stimulus is greater. The structure of the lung and the degree of rapidity of the movement of the blood-globules must be carefully noted ; as the former becomes more complicated, and the latter augmented, the quantity of stimulus is higher, and, I need scarcely say, the degree of dynamic lower.

There is, indeed, no subject so replete with interest as the circulatory apparatus—pneumonic and systemic—in themselves, in the different orders of animated being, and in reference to the Law of Life. The entire apparatus consists of—1, The minute arteries ; 2, The minute veins ; and 3, The intermediate blood channels, or, as I have proposed to denominate them—from the important fact that all the changes which take place in blood take place in them—the methæmatus, or blood-changing, channels. These vessels are specifically distinct, a distinction on which I have insisted on another occasion.

I must now, gentlemen, in the last place, bring before you certain *results* of that Law of Life which I have thus very inadequately sketched. In doing this, I shall be compelled to repeat some of the preceding remarks ; but I prefer this to the alternative of leaving my sketch incomplete.

The first remark I have to make in regard to the results of the Law of Life, relates to the temperature of animals of high dynamic and of low respiration, and consequently of low temperature. Such animals are said to be of *cold blood*. This expression is inaccurate ; no animal is positively of cold blood. The species of lowest temperature is still of a temperature higher than that which would subsist absolutely without respiration, and its blood is only low in temperature, without being as cold as the surrounding medium.

Even amongst fishes, some are high, others low, feeders and breathers, with a corresponding temperature. The trout can only live at the surface of a limpid stream, breathing highly oxygenated water, and feeding on the insects immediately on that surface ; the carp, on the contrary, lives and breathes lowly, at the lowest parts of stagnant pools. The trout is comparatively a fish of high stimulus—food and respiration—and temperature, and of low dynamic ; the carp of high dynamic and low stimulus. The trout dies almost immediately, if taken out of its crystal element ; the carp will live for days in wet moss—that is, out of its own element, abundantly

supplied with moisture, or in a limited portion of water ill supplied with mixed atmospheric air.

As we rise in the scale of animated beings, from the fish to the reptile, from this to the mammalia, and from these to birds, the respiration, and, with this, the temperature, also rises, the dynamic proportionately falling ; the temperature of the fish and reptile is slightly above that of the medium in which they dwell respectively ; that of the mammalia is about 98° ; that of the bird tribes, about 102° Fahr.

The temperature accurately coincides with the quality and quantity of food and the quantity of respiration, and is, in effect, the development of an internal stimulus from stimulant ingesta.

With temperature, there is also, probably, the evolution of the galvanic agency.

The galvanic apparatus, the thermometer, the quality of food, the quantity of oxygen, the power to bear the abstraction of these stimuli, or, in certain circumstances, their addition : all these are criteria of the place a given animal, in a given condition, ought to occupy in the zoological or physiological scale.

Growth, development, metamorphosis, nutrition, in ovo and extra ovum, are other results of the play of vital powers, dynamic and stimulus. With each of such changes in form, a change in kind of life, or a metabiosis, occurs.

Of these, hints have been dispersed in the preceding

remarks. If I have succeeded in giving you, Gentlemen, an adequate idea of them, and of the other topics involved in the development of the Law of Life, I shall feel much gratified. Pray accept my best thanks for your kind attention throughout this imperfect lecture.

POSTSCRIPT.

*Case of Drowning, protracted Submersion, Restoration ;
by Edward Cook, Esq. Guildford.*

FIELDER UNDERWOOD, æt. 16, an intelligent lad and a good swimmer, while in the act of winding up one of the sluice doors of the Mill-Mead Lock, Guildford, was suddenly immersed in the water, by the handle slipping off. The accident occurred on the 9th of July, at 6.15, P. M. The water was pouring with great force through the sluice hole into the lock, and he was consequently carried under the sluice door and jammed there. A man who was standing on the opposite side of the lock immediately ran round to his assistance, and succeeded in getting hold of the boy's hand, although he was immersed in a depth of from four to five feet of water ; but, although he applied all the strength in his power, he could not extricate him, in consequence of the lower extremities of the boy being drawn firmly under the sluice door, and jammed there by the force of the current of water in the river above.

The man, finding that his efforts to release the lad were of no avail, ran to a house two hundred yards distant for another handle (the handle having fallen into the water with the boy). The road he had to traverse was a difficult one; part of the way consisted of a narrow passage and a court-yard, he having to open a gate to get into it; and when he arrived at the house, the woman who occupied it was up stairs. She immediately came down and conducted the man through the house into a back yard, where he found a handle, with which he hastened back to the lock, and, with great presence of mind, at once determined not to wind up the door under which the boy was pressed, lest he should be carried by the current into the semicircular sluice canal, but to wind up to its full height the sluice door of the opposite side, in order to fill the lock as speedily as possible, and take away the great pressure of water which kept the poor boy a prisoner under the sluice door. He therefore, instead of running a little distance round, attempted to throw the handle across the river to a man on the opposite side; but in the attempt he failed, and the handle fell into the water. Another was then sought after, by running and shouting to some millers one hundred and fifty yards distant. The handle was obtained, and the one sluice door was wound up to its full height; and while the lock was filling, some persons imagined that they saw the boy's body in the agitated water which was in the lock; they thought that the boy had been carried through

the sluice canal ; and hooks were immediately obtained, but what they imagined was the boy's head turned out to be a tuft of weed. They then directed their search in the water above the lock, and found the body wedged under the sluice door ; and, although the lock was filled with water, and the pressure of water thus removed, they found that it was necessary to apply the handle to wind up the sluice door which was pressing upon him ; and when that was done, they immediately lifted the body out of the water by means of grappling hooks.

I have been particular in narrating all these minute circumstances, in order that an idea may be formed of the time the boy was under the water ; for he was entirely submerged from the moment that he fell in till the moment he was taken out. Now it takes three minutes and a half to fill the lock with water when both sluice doors are open to their fullest extent. When the accident occurred, but a small quantity of water had ran into the lock, and one door was wound up one third and the other one half its height ; the latter was partially blocked up by the boy's body, and the former could be wound up entirely only when the handle from the mill was obtained ; therefore the time which elapsed from the period of time that he was immersed till he was removed was considerable, and due to the following circumstances :

1stly. The attempt to rescue the boy in the first instance.

2ndly. The time lost in the efforts made to obtain the handles, and the accidental loss of one them.

3rdly. The endeavour to find the boy in the lock—due to an impression that he had been carried through the sluice canal.

The majority of those who saw the accident, and were present during the whole period of submersion, were of opinion that he was in the water more than ten minutes. From the time it occupies to fill the lock, combined with other circumstances, *I infer that he must have been submerged from seven to eight minutes, and certainly not less than seven.*

I arrived on the spot immediately after he was taken out of the water. The surface of the body was cold, the lips and cheeks blanched ; there were no signs of respiration ; the heart was still ; the body was to all appearance inanimate—lifeless. The muscles were very relaxed. I immediately obtained the assistance of several of the bystanders, and first stripped the body of its clothing. I placed one man at each leg, one at the back, and one at the head to guide it right in the rolling, and another to administer a solution of heartshorn occasionally to the nostrils. I drew the tongue well forward, and saw that the throat was unobstructed. I then proceeded to act according to the rules of the Marshall Hall Method—my kind assistants rubbing the surface of the extremities back, &c. while I rolled the body from fifteen to eighteen times per minute. This was done on the grass, within fifteen yards of the spot where he was taken out. *After from five to seven minutes, the first gasp or inspiration was noticed ; the next, in about half a minute ; and then*

occurred about once in twenty seconds, more or less, and with some irregularity for from fifteen to twenty minutes; and after that time, the respirations became more frequent. At the end of thirty-five minutes or so, he breathed without my assistance, and the pulse could be felt at the wrist; but pulsation was felt in the femoral artery in Scarpa's triangle some minutes before it was felt at the wrist. After having thoroughly ascertained that he could breathe, I had him wrapped up in a blanket and conveyed home, where he was put to bed. The surface of the body was still cold; he was unconscious, and could not be roused by loud talking, &c. The pupils were much dilated. Respirations, 25, short and oppressed. Pulse weak, 50. Hot-water bottles were applied to his legs and feet, and a free current of air admitted through the room. At half-past seven P. M. Mr. Sells saw him, and recommended the application of a mustard cataplasm to the chest and abdomen. The pulse had risen in volume and frequency, being 64, and the respirations from 30 to 32, still very much oppressed; and on oscultating the chest, rough mucous crepitation and bronchial wheezing could be heard. The mustard plaster appeared to give him great pain; it remained on ten minutes, and made the skin red.

Mr. Sells again saw him with me at half-past nine P. M. The pulse had increased to 104, and the respirations to 52; excessive reaction had taken place, the surface of the body was very hot and dry, he was still unconscious, the dyspnœa very great. We made an

attempt to give him a little water out of a teaspoon, but he made no effort to swallow.

At midnight he swallowed a teaspoonful of warm tea, and said that it was "too sweet;" these being the first words he uttered after the occurrence of the accident; he slept till five A. M.

10th. At half-past six A. M. the skin was hot and dry, pulse 88, weak; respirations, 32; much oppressed, has not answered to any questions put to him. At half-past seven A. M. bowels relieved, and a large quantity of urine passed. Half-past nine, A. M.; is perfectly conscious, and cheerful; has no knowledge of the accident, and disbelieves its occurrence; he does not even recollect going to the lock. Complains of soreness and stiffness of the limbs. The surface of the extremities is still cold, but the surface of the other parts of the body is hot and dry. Hot flannels applied to the legs and feet; pulse 90, weak; tongue, white; six grains of calomel to be taken directly. At noon, vomited a small quantity of what appeared to be pure bile, *perspires freely*, pulse 90, stronger; eat a small quantity of light pudding; breathing much easier.

11th. Was purged freely several times by the calomel; enjoyed a good night's rest; pulse 80, soft and rather weak; respirations 25, deeper, and more natural; the temperature of the lower extremities was lower than of other parts of the body, and warmth was still applied; has no headache; complains of feeling stiffness in the limbs.

A grain of calomel was given at night, and a senna draught the following morning.

12th. Stomach irritable; vomited after taking the pill and draught; tongue less white; pulse 84, stronger. To have light diet.

July 13th. Health improved in all respects, and considers that he is "himself again."

EDWARD COOK,

Assistant to Messrs. STEDMAN, SELLS, and STEDMAN,
Surgeons, Guildford.

I trust that this important case, with its details, will lead to a renewed and more careful observation of the length of *time* during which the human subject may be deprived of respiration, without extinguishing all hope of restoration.

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